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LAUNCH, A COMPUTER CODE FOR DETERMINING LAUNCH VEHICLE RELIABILITY

September 1977

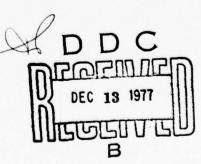


Final Report

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AIR FORCE WEAPONS LABORATORY Air Force Systems Command Kirtland Air Force Base, NM 87117



This final report was prepared by the Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico, Job Order 20070311. Lieutenant Marcía A. Thornton (NSQ) was the Laboratory Project Officer-in-Charge.

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1Lt, USAF

Project Officer

FOR THE COMMANDER

DERMOD KELLEHER

Chief, Power/Branch

Chief, Nuclear Systems Division

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PREFACE

The work described in this report is part of the total technical support provided by the Power Branch, Nuclear Systems Division of the Air Force Weapons Laboratory (AFWL/NSQ) to the Directorate of Nuclear Surety (AFISC/SN) on the Viking, Lincoln Experimental Satellites 8 and 9, and Mariner Jupiter/Saturn missions.

The author would like to acknowledge the assistance, in the form of a nonlinear regression curve fitting subroutine, provided by the Mathematics Section, Technical Branch, Technology Division of the AFWL.



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SECTION I

INTRODUCTION

The Interagency Nuclear Safety Review Panel (INSRP) is tasked with reviewing the safety analyses of space launches carrying nuclear power sources. After review of the launch safety analysis, the INSRP prepares a Safety Evaluation Report (SER) for submission to the National Security Council and ultimately to the President. The SER contains a recommendation for launch approval or disapproval.

These safety analyses are performed under Energy Research and Development Administration (ERDA) contract and include inputs from many sources including the launch vehicle contractors. For many years the INSRP has accepted the booster vehicle and upper stage failure rates provided by the contractors while wondering how these failure rates compare with the performance history of the vehicle. The Power Branch, Nuclear Systems Division of the Air Force Weapons Laboratory (AFWL) has developed a computer code, LAUNCH, to determine historical failure rates in an effort to resolve the potential differences between contractor supplied and historical failure rates. LAUNCH allows the user to obtain the launch history, historical failure rate, and projected reliability of specific launch vehicles using various reliability growth techniques.

Preliminary results of LAUNCH analysis on Viking, Lincoln Experimental Satellites 8 and 9 (LES 8/9), and Mariner Jupiter/Saturn (MJS) have been incorporated into the SERs for those launches. Similar results for other launches and launch vehicles should prove useful to the INSRP in its review of safety analyses.

SECTION II

COMPUTER CODE

The main program, LAUNCH, is a short bookkeeping program which calls subroutines as directed by data cards input to it. The main program and various subroutines will be discussed individually here. Listings of the main program and subroutines appear in the Appendix. Formats for the data cards are discussed in Section V.

A flowchart of LAUNCH appears as figure 1. The data entry cards are read into the proper arrays. An end-of-file (EOF) card terminates the data entry cards. Subroutine RENMER is called to sort the data entries chronologically and to merge them with the main data file which has been stored on tape or permanent file. The reordered and merged main data file is then written onto tape or permanent file for future use. Data cards indicating the desired output information are read next, and the appropriate subroutines are called. Another EOF card terminates the data cards. This ends the program execution.

RENMER is flowcharted in figure 2. This subroutine uses a "shell" sort to chronologically order the data entries from cards. The reordered set is then written on a scratch file. This scratch file and the main data file are then merged into one single file with any duplicate entries combined into a single entry. Duplicate entries can occur because information is obtained from a variety of sources and more than one source may provide information on a given launch. Program control is returned to LAUNCH to output the requested information using this updated data file.

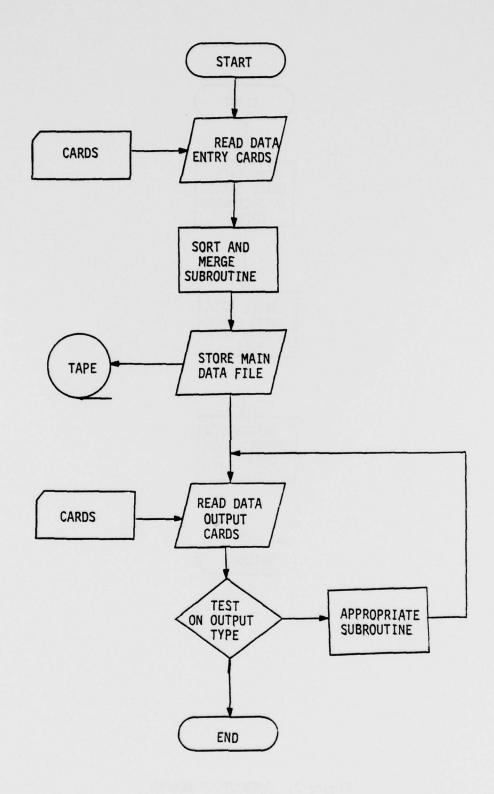


Figure 1. PROGRAM LAUNCH

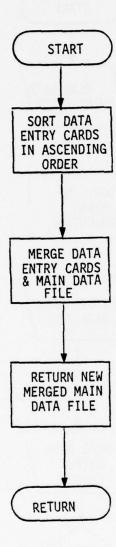


Figure 2. SUBROUTINE RENMER

Subroutine CHANGE appears in figure 3 in flowchart form. CHANGE uses a dummy variable as a temporary storage location for switching the items in the data entries.

A flowchart of VEHICLE appears as figure 4. This subroutine takes the data entries which contain the desired output information from the main data file and enters them into a vehicle array. Data entries are tested to determine if they contain the desired vehicle and, if only failures are desired, if the launch result is a failure. The vehicle array is then printed for use.

Subroutine FAILRAT is flowcharted in figure 5. Using success and failure counters, FAILRAT determines the historical reliability after each launch. This can be done using all launches or for only the last NO launches, where NO is supplied by the user. A success is the successful performance of the desired vehicle; a failure of a booster vehicle is a no-test for the upper stage if the upper stage is the desired vehicle.

Figure 6 is a flowchart of FAILLOC. This subroutine determines the percentage of failures occurring during each launch phase: pad, land, ascent, orbital. These percentages can be for all launches or for only the last NO launches where NO is input by the user.

A flowchart of CURVIT appears as figure 7. CURVIT uses a least-squares nonlinear regression subroutine to determine a best fit to the historical data. Four general equations are currently employed (Y = reliability; X = launch number; A, B, C = curve fit parameters):

$$Y = A + Be^{CX}$$
 (1)

$$Y = Ae^{Be^{CX}}$$
 (2)

$$Y = A \left(1 - \frac{B}{CX + B}\right)$$
 (3)

$$Y = Ae^{B/X}$$
 (4)



Figure 3. SUBROUTINE CHANGE

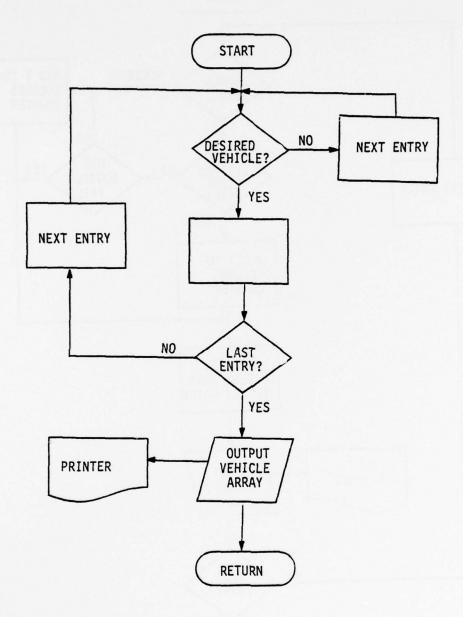


Figure 4. SUBROUTINE VEHICLE

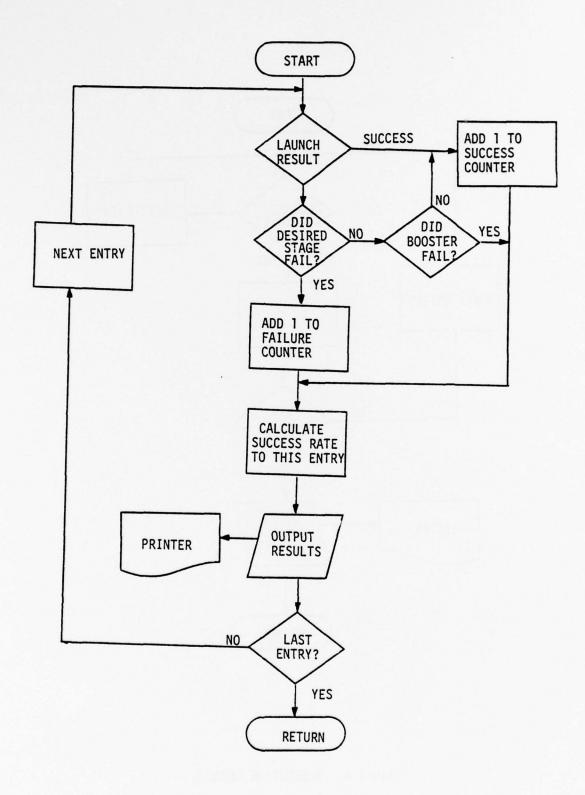


Figure 5. SUBROUTINE FAILRAT

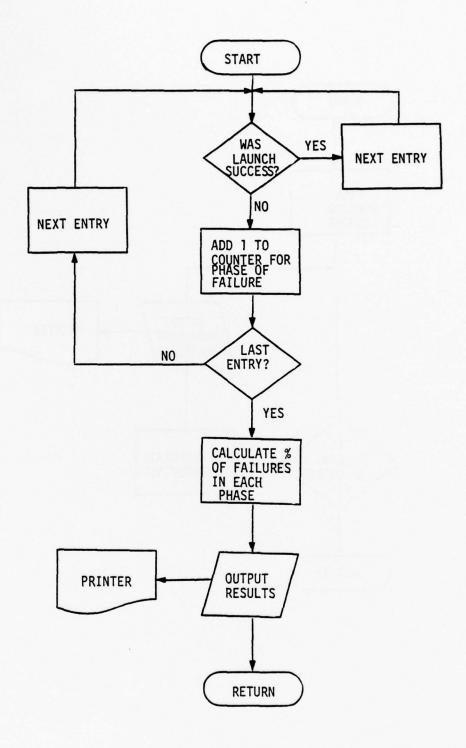


Figure 6. SUBROUTINE FAILLOC

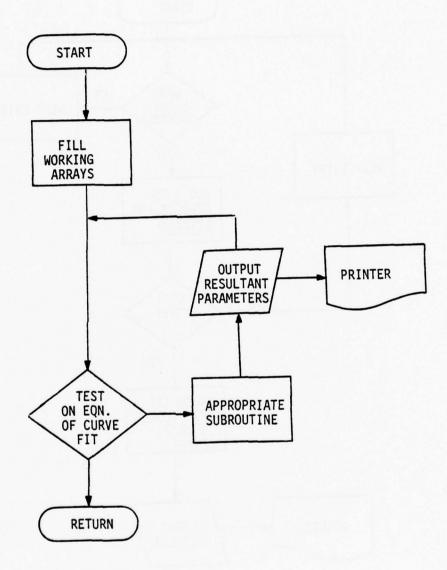


Figure 7. SUBROUTINE CURVIT

SECTION III

SOURCES OF INFORMATION

The information used to build the data file comes from a variety of sources. The original starting point was the TRW Space Log (reference 2). This provided basic information on launches including date, vehicle, project director, and mission success or failure. Another major source was NASA Pocket Statistics (reference 3) which provided the same type of information on NASA missions. Vandenberg AFB Launch Summary (reference 4) yielded additional data on many boosters which have been used as reentry vehicles rather than space launches. In instances where it was available, contractor information on launch vehicles was also included (reference 5, 6).

SECTION IV

COMPUTER DECK STRUCTURE

The program LAUNCH is written in ANSI standard FORTRAN and requires the appropriate control cards. Different parts of the card deck are separated by end-of-file (EOF) cards (also called end-of-section or end-of-partition). Figure 8 depicts the deck structure.

The control cards must request the storage device for the main data file to read and update the file. They also establish the language used and other peripheral equipment desired.

The main program and associated subroutines follow. Data entry cards are next and may be in any order.

The data output cards must be somewhat organized. First, the vehicle array must be formed (KEY \approx 0). Then any statistics desired may be determined using that array. If statistics on another vehicle are desired, the vehicle array for that vehicle must be formed first. Any number of vehicles can be examined sequentially during a computer run but only three booster and upper stages can be examined at one time. An EOF card terminates the computer run.

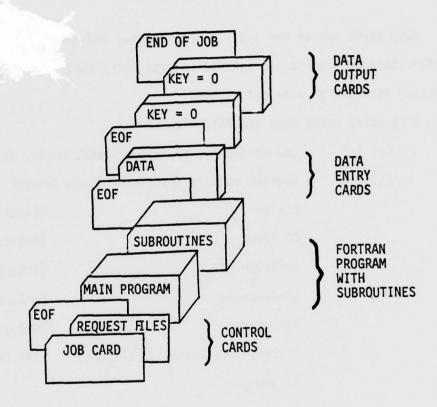


Figure 8. DECK STRUCTURE

SECTION V

DATA CARD FORMAT

Data cards are of two types: data entries and data output. Additional information on launches is entered on data entry cards. The type of output desired is coded on data output cards.

Data entry cards have the following format:

Col 1-6	Launch date as an integer=year, m	onth, day
Co1 7-8	Booster vehicle designator as an	integer
	01=Thor	02=Atlas
	03=Scout	04=Titan II
	05=Titan III	06=Vanguard
	07=Redstone	08=Juno II
	09=Saturn	10=Jupiter
	ll=Titan III (w/solid strapons)	12=Titan I
	20=Unknown	

Col 9-10	Upper stage designator as an int	teger
	01=Agena	02=Centaur
	03=Able	04=Delta
	05=Burner II	06=Transtage
	10=None	20=Unknown

Col 11-14 Project director as an alphanumeric (e.g., USAF, NASA, USN)

Col 15 Source of information as an alphanumeric

B=Booster Contractor

E=Air Force Eastern Test Range (AFETR)

N=NASA Pocket Statistics

0=Other

T=TRW Spacelog

U=Upper Stage Contractor

W=Western Test Range at Vandenberg Air Force Base (VAFB)

Col 16 Launch result as an alphanumeric

F=Failure

S=Success

Col 17 Failure phase as an alphanumeric

A=Ascent

L=Land

0=Orbital

P=Pad

Col 18 Failed stage as an alphanumeric

B=Booster Vehicle

U=Upper Stage

Col 19 Type of launch as an integer

1=Space Launch

2=Training

3=Test

4=Reentry Test Vehicle
5=Suborbital
6=Unknown

Col 20 Multiple launch indicator as an integer

O=First launch of given vehicle on that date

l=One multiple launch of vehicle on that date

The sample data entry card in Figure 9 adds a launch of a Thor Delta spacecraft combination on 13 May 1960 to the main data file. The launch was a NASA space launch which failed during ascent due to an upper state failure. Information is available from Thor contractor.

Data output cards have the following format:

Col 1-2 Output key as an integer

Negative=Automatic call sequence to output complete statistics on desired launch vehicle (this does not form vehicle array)

O=Vehicle history output (this must be done before statistics are requested because the statistics are derived from the vehicle array)

1=Failure rate statistics

2=Failure location statistics

50=Curve fit of data using forms as requested in Cols. 21-24

Col 3-4 Booster vehicle designator (see data entry card Col 7-8)
If zero, any booster may be considered.

6 0 0 5 1 3 0 1 0 4 N A S A B F A U 1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Figure 9. DATA ENTRY CARD

0 0 0 1 0 1 0 0 0 0 F 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 15 17 18 19 20 21 22 23 24

Figure 10. DATA OUTPUT CARD

Col 5-6 Upper stage designator (see data entry card Col 9-10)
If zero, any upper stage may be considered.

Col 7-10 Percentage of launches to be used in deriving statistics

(zero causes all launches to be considered, negative number causes a summary only to be printed).

Col 11 Blank

Col 12 Launch result to be considered

F=Failures only

S=All launches

Col 13-14, 17-18 Additional booster vehicle designators

Col 15-16, 19-20 Additional upper stage designators

Col 21-24 Curve-fit forms indicators

Col 21=1 fit to A+Be^{CX}

Col 22=1 fit to AeBecx

Col 23=1 fit to A $(1 - \frac{B}{CX+B})$

Col 24=1 fit to $Ae^{B/x}$

The sample data output card in figure 10 requests the vehicle history (failures only) for the Thor Agena spacecraft combination.

SECTION VI

SAMPLE OUTPUT

Figures 11 to 15 show the output generated by LAUNCH. A discussion of each figure will demonstrate its features and uses. The Centaur upper stage will be used as an example.

Figures 11 and 12 are representative of the output from subroutine VEHICLE. The output is labeled for the vehicle being considered and for failures only or all launches. The columns are basically self-explanatory. Abbreviations for the source of information are:

TRW - TRW Space Log

NASA - NASA Pocket Statistics

BV - Booster vehicle contractor

UV - Upper stage contractor

ETR - Air Force Eastern Test Range

WTR - Western Test Range (Vandenberg Air Force Base)

OTHER - Other sources

The launch types are:

SPACE - Orbital flight or space probe

TRNG - Training (these are boosters only in general)

TEST - Vehicle test

RTV - Reentry test vehicle

SUBORB - Suborbital flight

TOTAL FAILURES FOR CENTAUR GDC

FAILURE STAGE LOCATION	A	A	0	0	A	A
FA	n	n	n)	n	n
LAUNCH TYPE RESULT	IL.	ட	ш	L	L	Ŀ
LAU TYPE	Space	Space	Space	Space	Space	Space
OTHER						
FION						
SOURCE OF INFORMATION NASA BV UV ETR WTR						
F INF	×	×	×	×	×	×
SCE 0 BV	×	×	×	×	×	×
SOUF	×	×	×	×	×	
TRW	×	×	×	×	×	×
PROJECT DIRECTOR	NASA	NASA	NASA	NASA	NASA	SN
UPPER STAGE	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur
BOOSTER L	Atlas	Atlas	Atlas	Atlas	Atlas	TIII Solid
DATE	5/8/62	6/30/64	12/11/64 A	11/30/70	5/8/71	2/11/74

Figure 11 Output from Subroutine VEHICLE (Failures Only)

CDC
CENTAUR
FOR
HISTORY
VEHICLE
FOTAL VE
2

LURE LOCATION	A	•	<0	ے															0		¥									V								
FAILURE STAGE LOCA	n	:	> =	œ)		>									=>								
LAUNCH E RESULT	L L. (νı	_ 1_		S	s	s	s	s	ý,	<i>ب</i> د	nu	n v	'n	y v	S	s	S	ب با	S	LL (so c	nu	n	nu	, v	o v	S	S	L	s	S	S	S	s c	n 0	n v	,
LAL	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	Space	
OTHER																																						
MTR																																						
SOURCE OF INFORMATION ASA BV UV ETR WTR																																						
JE IN	×:	× :	< ×	×	×	×	×	×	×	×:	× >	< >	< >	< ×	: ×	×	×	×	×	×	×:	×:	< >	< >	< >	< >	< ×	×	×	×	×	×	×	×	× >	< >	< ×	:
RCE (BV	×	× >	< ×	×	×	×	×	×	×	×:	× >	< >	< >	< ×	: ×	×	×	×	×.	~	×:	×:	< >	< >	< >	< >	×	×	×	×	×	×	×	×	× >	< >	< ×	:
SOUF	×:	× >	< ×	×	×	×	×		×	×:	× >	< >	< >	< ×	: ×	×	×	×	×	×	×:	×:	< >	< >	< >	< ×	×	:										
TRW	×:	× :	< ×	×	×		×	×	×	×:	× >	< >	< >	< ×	×	×	×	×	×	×	×:	×:	< >	< >	< >	< >	×	×	×	×	×	×		×				
PROJECT DIRECTOR	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA	ACAN	NASA	SSC	NASA	NASA	181	181	NASA	NASA	NASA	CSC	NASA	Sn	CSC	Germ	NASA	NASA	Germ	LSC	USAF							
UPPER STAGE	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur	Contaur	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur	Centaur						_	Contain	Centaur							
BOOSTER	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	At 130	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	Atlas	TIII Solid	Atlas	TIII Solid			TIII Solid	Atlas	Atlas							
DATE	5/8/62	11/2//63	12/11/64	3/2/65	8/11/65	4/8/66	2/30/66	9/50/66	10/26/66	4/11/67	1/14/6/	19/0/6	1/1/68	8/10/68	12/7/68	2/24/69	3/27/69	8/12/69	11/30/70	1/52/11	5/8/71	5/30//1	02/61/71	2//57/1	3/3/12	8/21/72	4/6/73	8/23/73	11/3/73	2/11/74	11/21/74	12/10/74	8/20/75	9/9/15	1/15/76	9//67/1	7/22/76	

Figure 12. Output from Subroutine VEHICLE (All Launches)

Failure locations used are:

- P Failure occurred on launch pad or resulted in a pad impact
- L Failure occurred over land
- A Failure occurred during ascent over water before achieving orbit
- 0 Failure occurred in orbital phase

Note that the failures in figure 11 are only Centaur failures; the booster failure is not listed. The launches are listed in chronological order and show the basic information at a glance. If more detailed information is desired, it can be obtained from one of the sources marked with an "X".

Figure 13 is a sample output from subroutine FAILRAT. The columns are self-explanatory. Note that the failure of the booster does not affect the success ratio of the upper stage.

The percentages of failures during the various launch phase are shown in figure 14. If the phase of failure is not known, that failure is not considered in determining the percentages.

Figure 15 shows the output of subroutine CURVIT, the reliability growth curve-fitting subprogram. The equations can be plotted as in figure 16 with the historical data to graphically show the trends for the vehicle being considered.

CENTAUR GDC

Adjusted Cumulative Success/Failure Ratio for Last 33 Flights of a Total of 41.

LAUNCH NUMBER	RESULT	STAGE	TOTALS S F	PERCENT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37	F	U U U U	S 0 1 1 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	0.00 50.00 33.33 25.00 40.00 50.00 57.14 62.50 66.67 70.00 72.73 75.00 76.92 78.57 80.00 81.25 82.35 83.33 84.21 80.00 80.95 77.27 78.26 79.17 80.77 81.48 82.14 82.76 83.33 83.87 81.25 84.38 84.38 87.50 90.63 90.91
38 39 40 41	\$ \$ \$		30 3 30 3 30 3 30 3	90.91 90.91 90.91 90.91

Figure 13 Output from Subroutine FAILRAT (Chronological)

CENTAUR GDC

Adjusted Failures Classed by Location for Last 33 Flights of a Total of 41.

LOCATION	FAILURES	PERCENT
Pad	0	0.00
Land	0	0.00
Ascent	2	66.67
Orbital	1	33.33
Total	3	100.00

Figure 14 Output from Subroutine FAILRAT (Summary)

The curve fit for this data is of the form:

Reliability = A * EXP(B * EXP(C * Launch Number))

With the Parameters A, B, C as follows:

A = .8099545744E+00

B = -.8207599285E+00

C = -.9104745067E+00

The curve fit for this data is of the form:

Reliability = A * (1 - B/(C * Launch Number + B))

With the Parameters A, B, C as follows:

A = .8764411049E+00

B = .2880982693E+15

C = .2880982693E+15

The curve fit for this data is of the form:

Reliability = A + B * EXP(C * Launch Number)

With the Parameters A, B, C as follows:

A = .8199671974E+00

B = -.2989172644E+00

C = -.4309589840E+00

The curve fit for this data is of the form:

Reliability $\approx A * EXP(B/Launch Number)$

With the Parameters A, B as follows:

A = .8328733128E+00

B = -.3642819210E+00

Figure 15. Output from Subroutine CURVIT

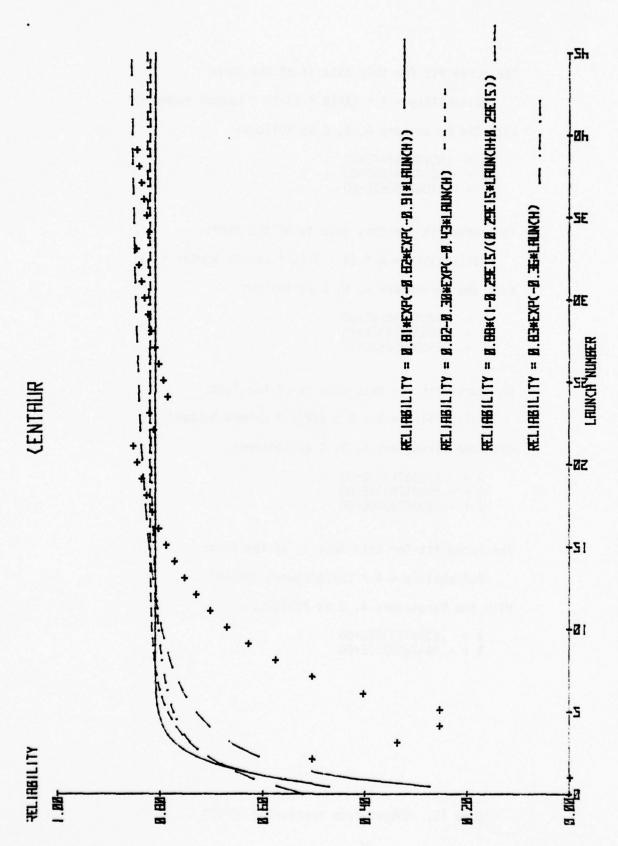


FIGURE 16. PLOT OF EQUATIONS DETERMINED BY SUBROUTINE CURVIT

SECTION VII

RESULTS

LAUNCH has been used to provide preliminary results for use with the safety analyses of the Viking, LES 8/9, and MJS missions. These results give a historical reliability which is used to scale the failure probabilities originated by the analyses.

The booster vehicle for all three missions is the Titan III with strap-on solid rocket motors. This vehicle has had 32 flights and 32 successes. Therefore, it is considered very reliable, and the manufacturer's failure probability of 98% could be used directly.

The Viking and MJS missions use a Centaur upper stage. From Jan 1968 to Jun 1974, there were 21 launches with 19 successes which is a reliability of 90.48%. This is lower than the manufacturer's reliability, and some scaling was done to reconcile the numbers.

LES 8/9 uses a Transtage upper stage. From Jan 1968 to Jun 1974, there were 12 launches with 11 successes which is a reliability of 91.67%. This is also lower than the manufacturer's reliability, and scaling was done before the reliabilities were utilized.

Another consideration is the apportionment of failure probabilities to the launch phases. If all launch vehicles are considered, these figures are:

Pad 5%

Land 5%

Ascent 63%

Orbital 27%

All launches were considered because there have not been sufficient failures of any particular vehicle to accurately predict these percentages.

As information is gathered, more accurate results will be obtained from LAUNCH. These results should prove useful to the INSRP review of nuclear power source launches.

APPENDIX

LISTING OF LAUNCH

The following listing of LAUNCH and its subroutines is provided for the reader who is interested in the details of the program logic. Comments are included to explain the workings of the program and to separate it into logical units.

	UNCH 74/74 DPT=1 FIN 4.6+433 0	
		FI
	17 APE 31	FI
	AT AFCO	-
-	TYPE STATEMENTS FOR THE VARIABLES	<u> </u>
-	· · · · · · · · · · · · · · · · · · ·	_F.I
		FI
	INTEGER JRGUAT	E
	INTEGER G1,G2+G3+C4	FI
	INTEGER GUOST, UPPER, BY, JY, ALN	FI
	INTEGER dv:,dve,uv:,uv2	FI
	- INTEGER SUUG,FAIL	FI
	REAL LOS	
- -		
e	THE COMMON BLOCKS ARE USED FOR SEPARATE PURPOSES	-₽I
-6 -	BLUGK *DATAIN* CONTAINS THE MAIN DATA FILE	
- -	BLOCK BATAGUT CONTAINS THE OUTPUT SPECIFICATIONS	FI
-6-		FI
-6-		FI
- 		FI
	- COMMON /BATAIN/ ORGANIAMENDAT-IDATE(2000).8005T(2000).UPPEA(2000).	FI
	LSOUM(20vu) vmES(2000) vL0G(2000) vP600[R(2000) vS[(2000,7) vS[6(2000) vL	FI
	2FYP(2010) - WLTLA(2000) - ALN	100
-		FI
-	CONTINUOSE LES HAVE LES HAVE SVELLE SVELLE SVELLE STEELE A THORSE A COMPONE	
	1, UCONF(2C) , RESU, LATYP(6)	-FI
		107
•	COMMON /STORIT/-SUCCESSODI FAIL (1533) RAT(1564) MEAD(12)	
_	Onthor Parket Sone Charles State Sta	-
-		
•		- 7 1
~	THE DATA WLOCKS SET CERTAIN VARIABLES TO ASSIGNED VALUES	
-		
	LAUNCH TYPE (*LATYP*), BOOSTER VEHICLE (*BY 6H*), UPPER STAGE (*	300
-	300 STER CONTRACTOR (*30 ONT*), AND UPPER STAGE CONTRACTOR (*UCON	100000
6	4SSIGNEO	
-6		
	- UATA LATYP/6H SPACE,6H TRNG,6H TeST,6H RTV,6HSUBORB,6H /	
- G		
	- JATA BVEH/LONTHOR	_ F.I
	110HFITAN III -10HVANGUARD -10HREDSTONE -10HJUNO II -10HSAFURN	_FI
	2 -+10HJUPIFE- +11HTIII SOLIO+10HTIFAN I -+7(16H	_FI
		FI
	2 - 10HJUPITE- ,1JHTIII SOLIO,10HTITAN I ,7(16H),10H 3UNKNOHN /	FI FI FI
 	2 -+10HJUPIFE- +11HTIII SOLIO+10HTIFAN I -+7(10H	FI FI FI
	2 - 10HJUPITE- ,1JHTIII SOLIO,10HTITAN I ,7(16H),10H 3UNKNOHN /	FI FI FI
	2 - 10HJUPITE 11HTIII SOLIO-10HTITAN I - 7(1CH) - 10H 3UNKNOHN / 10HGENA - 10HGENTAUR - 10HABLE - 10HDELTA - 110HBURNER II - 10HTRANSIAGE - 13(10H) - 1-10HUNKNOHN /	FI FI FI FI FI
	2 - 10HJUPITE 11HTIII SOLIO-10HTITAN I - 7(1CH) - 10H 3UNKNOHN / 10HGENA - 10HGENTAUR - 10HABLE - 10HDELTA - 110HBURNER II - 10HTRANSIAGE - 13(10H) - 1-10HUNKNOHN /	FI FI FI FI FI
	2 - 10HJUPITE- ,1JHTIII SOLIO-10HTITAN I ,7(1CH)-10H 3UNKNOHN / DATA UVEH/10HAGENA - 10HCENTAUR - 10HABLE - 10HDELTA - 110HBURNER II +10HTRANSIAGE +13(10H)+10HUNKNOHN / JATA BCOHT/10HMOAC - 10HGDC +10HLIV +2(10HMC)	FI FI FI FI FI
	2 - 10HJUPITE- ,1JHTIII SOLIO-10HTITAN I ,7(1CH)-10H 3UNKNOHN / DATA UVEH/10HAGENA - 10HCENTAUR - 10HABLE - 10HDELTA - 110HBURNER II +10HTRANSIAGE +13(10H)+10HUNKNOHN / JATA BCOHT/10HMOAC - 10HGDC +10HLIV +2(10HMC)	FI FI FI FI FI
-6	2 - 10HJUPITE- ,1JHTIII SOLIO-10HTITAN I ,7(1CH)-10H 3UNKNOHN / DATA UVEH/10HAGENA - 10HCENTAUR - 10HABLE - 10HDELTA - 110HBURNER II +10HTRANSIAGE +13(10H)+10HUNKNOHN / JATA BCOHT/10HMOAC - 10HGDC +10HLIV +2(10HMC)	FI FI FI FI FI
- G	2 - 10HJUPITE- ,1JHTIII SOLIO,10HTITAN I ,7(16H),10H 3UNKNOHN / OATA UVEH/16HAGENA ,10HCENTAUR ,10HABLC ,10HDELTA , 110HBURNER II ,10HTRANSIAGE ,13(10H),10HUNKNOHN / JATA BCOHT/16HADAC ,10HGDC ,10HLIV ,2(10HMC), 1,5(10H),10HMC ,3(10H)/	FI FI FI FI FI FI FI
- c	2 - 10HJUPITE- ,1JHTIII SOLIO,10HTITAN I ,7(16H),10H 3UNKNOHN / OATA UVEH/16HAGENA ,10HCENTAUR ,10HABLC ,10HDELTA , 110HBURNER II ,10HTRANSIAGE ,13(10H),10HUNKNOHN / JATA BCOHT/16HADAC ,10HGDC ,10HLTV ,2(10HMC),	
- G	2 - 10HJUPITE- ,1JHTIII SOLIO,10HTITAN I ,7(16H),10H 3UNKNOHN / OATA UVEH/16HAGENA ,10HCENTAUR ,10HABLC ,10HDELTA , 110HBURNER II ,10HTRANSIAGE ,13(10H),10HUNKNOHN / JATA &CONT/16HADAC ,10HGDC ,10HLIV ,2(16HMC),	
G.	2 - 10HJUPITE- ,1JHTIII SOLIO,10HTITAN I ,7(16H),10H 3UNKNOHN / OATA UVEH/16HAGENA ,10HCENTAUR ,10HABLE ,10HDELTA , 110HBURNER II ,10HTRANSTAGE ,13(10H),10HUNKNOHN / JATA &COMT/16HADAC ,10HGDC ,10HLTV ,2(16HMC), 1,5(16H),16HMMC ,3(10H)/ DATA UCONT/10H ,10HGDC ,10H)/	
\$ \$ \$	2 - 10HJUPITE- ,1JHTIII SOLIO,10HTITAN I ,7(1CH),10H 3UNKNOHN / OATA UVEH/1CHAGENA ,10HCENTAUR ,10HABLE ,10HDELTA , 110HBURNER II ,10HTRANSIAGE ,13(10H),10HLIV ,2(10HMMC / JATA &CONT/10HJAC ,10HCDC ,10HLIV ,2(10HMMC),	
6 666	2	
6 6043	2 - 10HJUPITE- ,1JHTIII SOLIO,10HTITAN I ,7(1CH),10H 3UNKNOHN / OATA UVEH/1CHAGENA ,10HCENTAUR ,10HABLE ,10HDELTA , 110HBURNER II ,10HTRANSIAGE ,13(10H),10HLIV ,2(10HMMC / JATA &CONT/10HJAC ,10HCDC ,10HLIV ,2(10HMMC),	

ROBRAM LAU	NGA 74/74 9PT=1 FTN 4.6+483	88/25
	1G(I),STG(I),LTYP(I),MULTLA(I)	F-IT
		FII
	IF THE LAUNCH TYPE IS NOT KNOWN (I.E. EQUALS OF THE INDICATOR	
	IS SET TO 6 AHICH SIVES A BLANK LAUNCH TYPE IN THE OUTPUT	ETI
		FII
	IF (LTYP(I).EQ.)) LTYP(I)=6	FII
-		
	THE DATA ENTRY GARDS ARE TERMINATED BY AN END-OF-FILE CARD	FII
	IF (EQF(5)) +-2	FII
		FII
	THE ARRAY ASTA IS BLANKED TO ELIMINATE CRRONEOUS DATA WHEN THE	
6	DATA ENTRY GARDS ARE MERGED WITH THE MAIN DATA FILE	
Č	SALE ENTRY SAROS ALE-TICKSES WITH THE HALL SALE VILLE	FII
	2 DO-3-J=1-7	FII
		FII
	3 SI(I, 4)=1H	FIT
	40 10 1	FLI
	4 NEHOATSIG1	FII
	4 *C+04+31-1	FIT
	SUBHOUTING RENNER IS CALLED TO SORT THE DATA ENTRY CARDS INTO	
G	CHRONOLUGICAL ORDER AND MERGE THEY-HITH THE MAIN DATA FILE INT	-FII
- 5	A SINGLE DATA FILE	FII
	CALL RENMER	
C		FIT
	HRITE THE DATA ENTRIES ONTO TAPE OR DISK	-FH
C		-FII
	00-5 I=1,0RGJAF	
	SOUR(I) - IH	FII
	5 HRITE (8-14) IDATE(I)-800SI(I)-UPPER(I)-PRODIR(I)-(ST(I-J)-J=1-7) 150UR(I)-RES(I)-0C(I)-STG(I)-LIYP(I)-MULTLA(I)	FIT
		_FII
- G	- HRITE AN END-OF-FILE MARK AND REMIND THE FILE	FII
3		-FII
	REALING 8	EII
3		
- 3	BATA OUTPUT CARDS ARE KEAD FROM THE CARD REACER	-FII
	THESE CARDS INDICATE THE TYPE OF OUTPUT DESIRED	FLI
- 6		
	6 READ 15-131 KEY-34-UV-NO-RESU-841-U41-842-U42-C1-C2-C3-C4	E.LT
		ELI
	AN END-OF-FILE CARD TERMINATES THE DATA SUTPUT CARDS	FI
ć		_ FI1
	IF (20F(51) 11.7	_FI
- 7		FI
- 3	A TEST ON *KEY DETERMINES WHICH DUTRUT SUBROUTINES ARE CALLED	FI
ć .		FI
- 0	7 IF (KEY) 10,4.3	-FI
		. EI
G .	MHEN THEY THE VEHICLE ARRAY IS FURHED ACCORDING TO THE	EI
_ 6	SPECIFICATIONS ON THE WATA OUTPUT CARD.	FI
_ 6	SECULTURA LURA DE LAS DALA DULA DE CARCO	FI
',	A SALL VEHICLE	FI
	30 10 6	FI
		FT
- C	HHEN TKEY IS POSITIVE ITS VALUE DETERMINES WHICH SUBROUTINE	

PHOGRAM LAUNGH	74/74	JPF=1		FFN 4.5+43	13 08/25/
	CALLED	THE VALUE OF *N	A IS USED TO DETE	2MINE THE P	ERCENTAGE FITT
			RED BY THE SUBROU		- FLTI
					FIII
9-15	- IKEY-EQ-1	L CALL FALLRAT	(NO)		FIII
			(NO)		FIT
			(NO-C1-C2-C3-C4)		FIII
					FII
G			~		FITI
			- AUTOMATIC SEQUEN		
			IS USED TO DETE		
			RED BY THE SUBROU Y USES ALL LAUNCH		
					- FIT
CA	LL CURVIT	(NO,1,1,1,1)			FIT
					
6					- FITI
	THE PROCK	AM IS COMPLETED			FIT
G					£I11
GA	LL EXIT				FITT
G	-EGRHAT ST	AT-MENTS			FITI
c					EIII
13 FU	MMAF (312-	14,42,412,4111			FIII
EN	7-T				FITI
					
					-

	74/74 OPT=1 FIN 4.64433
	- SUBROUTINE KENNER
G	
<u>_</u>	TYPE STATEMENTS
- 0	
	INTEGER ORGAT
	INTEGER BOOST, UPPER
	OINENSION +15(7) + 455(7)
	COMMON BLOCKS
	- COMMON / DATAIN/ ORGUAT, NEHDAT, IDATE(2000) . HOOST(2000) . UPRER(2010).
	150UR(2000) .RES(2000) .LOC(2000) .PRODIR(2000).ST(2000,7).STG(2000).
	2330K(2000)+4ULTL4(2000)+ALN
_	611116001/10616416007/461
-	PERFORM A +SHELL+ SORT ON THE DATA ENTRY CARDS TO ORDER THEM
	CHRONOL DEICALLY
	N- U*U0.4*
	N=NEHOAF
	- 1 H=N/2
	- IF (N-EQ-3) 53 F3 10
	-2 I=J
	3 IF (IDATELL)-IDATELL+N1)-9,4,8
	4 IF (BOOST(I)-BJOSF(I+N))-9,5,8
	5 IF (UPPER(I)-UPPER(I+N)) 9,6,8
	-6 IF (PRODIR(I)-PRODIR(I+N)) 3,7,8
	7 IF (MULTLA(I)-MULTLA(I+N)) 9,9,8
	SUBROUTINE *CHANGE* CHANGES ENTRY *I* WITH ENTRY *I*N*
G	
	8 CALL CHANGE (I. IAN)
41	IF (I.62.1) 60 TO 3
	9_1=1+1
	#F (J=K) 2,2,1
c.	
	WRITE THE REDROCKED ENTRIES ON A FILE FOR COMPARISON WITH THE
	MAIN DATA FILE
c	
•	10 00 11 I=1+NEMCAT
	11 HR ITE (3,34) IDATE(1),800S((1), UPPER(1),PRODIR(1),(ST(1,1),J=1,7)
10-0	- 1SOUR(I) - RESTIN - OCTI) - SIGTIN - ITPLIN - MULTLA(I)
	HEHING 3
Ģ	
	MERGE THE MAIN DATA FILE AND THE REORDERED DATA ENTRIES INTO A
	SINGLE FILE ALTH NO DUPLICATE ENTRIES (PUSSIBLE SINCE MANY
3	SOURCES UF INFORMATION ARE USED!
	THE MAIN DATA FILE IS UN TAPELO
	THE DATA ENTRIES ARE ON TAPES
- C	
	10=16
-	SET COUNTER TO ONE
C	

IF (V56.EQ.1HB) SI(I,3)=1HX IF (V56.EQ.1HU) SI(I,4)=1HX IF (V56.EQ.1HE) SI(I,5)=1HX	98
Set Same File INDICATOR TO ZERO	
IFLAG=0	
C IF NO DATA ENTRY CARDS HAVE BLEN READ, COPY DATA FILE FROM DATA FILE NOTION ONE C SET SAME FILE INDICATOR TO ONE IF (NEHDAT.eq.0) IN=10 C READ FILE READ FILE READ (IN, 14) IV51, IV52, IV53, V54, (V55(III), II=1,7), V56, V57, V54, V5 IV60, IV61 C CHECK FOR END-OF-FILE C CHECK FOR END-OF-FILE 12 EED (10, 34) IV11, IV12, IV13, V14, (V15(III), II=1,7), V16, V17, V18, V1 IV20, IV21 C CHECK FOR END-OF-FILE C G GHECK FOR END-OF-FILE C G GEAD FILE C G	
IAPE10 TO TARES C SLT SAME FILE INDICATOR TO ONE	
C Set Same File INDICATOR TO ONE IF (NEHOAT-EQ-0) IFWAG=1 IF (NEHOAT-EQ-0) IFWAG=1 IF (NEHOAT-EQ-1) IN=10 C READ FILE READ (IN, J4) IV\$1, IV\$2, IV\$3, V\$4, (\$5\$(II), II=1, 7), V\$6, V\$7, V\$54, V\$5 IV\$6, IV\$6 C CMECK FOR END-OF-FILE C IF (EOF(IN)) 32, 12 G READ FILE C 12 READ (IO, J4) IV\$1, IV\$2, IV\$3, V\$4, (\$\$\$(II), II=1, 7), V\$6, V\$7, V\$18, V\$1 IV\$20, IV\$2 C CMECK FOR END-OF-FILE C IF (EOF(IO)) \$1, 11 C C GOMPARE LAUNCH DATES = C IF (EQUAL DOMPARE FUNIMER C IF NOT EDUAL, FILE DATA ARRAY WITH EARLIER LAUNCH ENTRY C MAIN DATA FILE MAS EARLIER LAUNCH C MAIN DATA FILE MAS EARLIER LAUNCH C MAIN DATA FILE MAS EARLIER LAUNCH C IF (USE-EQ-1) IN STEI, 1) = IHX IF (V\$6, EQ-1) IN STEI, 1) = IHX	
F	
TF (NEMOAT.EQ.:) IN=10 C	
READ FILE	
READ (IN, 34) IV51, IV52, IV53, V54, (V55(III), II=1, 7), V56, V57, V58, V5 IV66, IV61 C CHECK FOR ENJ-OF-FILE IF (EOF(INI) 32, 12 O READ FILE 12 READ (IO, 34) IV11, IV12, IV13, V14, (V15(III, II=1, 7), V16, V17, V18, V14, V15(III, II=1, 7), V16, V17, V18, V15, V17, V18, V15, V17, V18, V16 C CHECK FOR END-OF-FILE C IF (EOF(IOI) 31, I3 C COMPARE LAUNCH DATES C IF ROUT EJUAL, FILL DATA ARRAY HITH EARLIER LAUNCH ENTRY C HAIN DATA FILE MAS EARLIER LAUNCH C MAIN DATA FILE MAS EARLIER LAUNCH C MAIN DATA FILE MAS EARLIER LAUNCH C MAIN DATA FILE MAS EARLIER LAUNCH D 15 JE1, Jenstein Still, Jen	
CHECK FOR END-OF-FILE G IF (EOF(IN)) 32-12 G READ FILE 12 READ (IO.J4) IVII.IVI2.IVIJ.VI4.(VISCII).II=1,7).VI6.VI7.VI8.VI LV20.IV21 G CHECK FOR END-OF-FILE G IF (EOF(IO)) II.II G G G G G G G G G G G G	59, L
IF (EOF(IN1) 32,12 G READ FILE 12 READ (10,34) [V11, [V12, [V13, V14, (V154][], II=1,7), V16, V17, V18, V1 1V26, IV21 G GRECK FOR END-OF-FILE G IF (EOF(IO1) 31,13 G GOMPARE LAUNCH DATES - G IF NOT EQUAL, COMPARE FUNTHER G IF NOT EQUAL, FILL DATA ARRAY WITH LARLIER LAUNCH ENTRY G IS (IV11-IV51) 00 14,14 G MAIN DATA FILE MAS EARLIER LAUNCH G MAIN DATA FILE MAS EARLIER LAUNCH 14 IDATE(I)=IV51 1900SI(I)=IV52 19PER(I)=IV53 PRODIK(I)=V54 00 15 J=1,7 15 SI(I,J)=V55(I) 1F (V56,EQ,IHN) SI(I,J)=IHX	
G READ FILE 12 READ (ID , 34) I + 11 , I + 12 + I + 13 , v14 , (v154 II) , II = 1 , 7) , v16 , v17 , v18 , v1 1	
12 READ (10,34) I + 11 + 1 + 12 + 1 + 13, + 14 + (+ 15 + 11) + 11 = 1, + 7) + + 16, + 17 + + 18, + 11 142 G	
G	19-1
IF (EQF(IQ)) 3:,13 G	
G IF EQUAL, COMPARE FURTHER G IF NOT EQUAL, FILL DATA ARRAY WITH EARLIER LAUNCH ENTRY G 13 IF ([V11 - [V51]	
G IF EQUAL, COMPARE FURTHER G IF NOT EQUAL, FILL DATA ARRAY WITH EARLIER LAUNCH ENTRY G 13 IF (IV11-IV51)	
G G AAIN DATA FILE MAS EARLIER LAUNCH G 14 IDATE(I) = I + 51 300SI(I) = I + 52 UPPER(I) = I + 54 DO 15 J = I + 7 15 SI(I, J) = V + 55(J) IF (V + 56 + EQ + I + N) SI(I, L) = I + X IF (V + 56 + EQ + I + N) SI(I, L) = I + X IF (V + 56 + EQ + I + N) SI(I, L) = I + X IF (V + 56 + EQ + I + N) SI(I, L) = I + X IF (V + 56 + EQ + I + N) SI(I, L) = I + X IF (V + 56 + EQ + I + N) SI(I, L) = I + X IF (V + 56 + EQ + I + N) SI(I, L) = I + X IF (V + 56 + EQ + I + N) SI(I, L) = I + X	
13 IF ([V11=[+51]	
G MAIN DAIA FILE MAS EARLIER LAUNCH 14 IDAIE(I) = I + 51 300SI(I) = I + 52 UPPER(I) = I + 53 PROBLE(I) = V 54 00 15 J = 1 + 7 15 SI(I, J) = V 55 (J) IF (V 56 + EQ - 1 H I) SI(I, L) = 1 H X IF (V 56 + EQ - 1 H I) SI(I, J) = 1 H X IF (V 56 + EQ - 1 H I) SI(I, J) = 1 H X IF (V 56 + EQ - 1 H I) SI(I, J) = 1 H X IF (V 56 + EQ - 1 H I) SI(I, J) = 1 H X IF (V 56 + EQ - 1 H I) SI(I, J) = 1 H X	
C 14 LDATE(I) = I + 51 300SI(I) = I + 52 UPPER(I) = I + 53 PROBLE(I) = V 54 00 15 J = 1 + 7 15 SI(I,J) = V 55(J) LF (V 56 + 62 + 1 + I) SI(I, 1) = 1 + X LF (V 56 + 62 + 1 + I) SI(I, 2) = 1 + X LF (V 56 + 62 + 1 + I) SI(I, 3) = 1 + X LF (V 56 + 62 + 1 + I) SI(I, 4) = 1 + X LF (V 56 + 62 + 1 + I) SI(I, 4) = 1 + X LF (V 56 + 62 + 1 + I) SI(I, 5) = 1 + X	
UPPEK(I)=I/53 PROBLE(I)=454 00 15 J=1+7 15 \$I(I,J)=455(J) IF (456+EQ.1HI) \$I(I,L)=1HX IF (456+EQ.1HN) \$I(I,C)=1HX IF (456+EQ.1HN) \$I(I,G)=1HX IF (456+EQ.1HU) \$I(I,G)=1HX IF (456+EQ.1HU) \$I(I,G)=1HX IF (456+EQ.1HU) \$I(I,G)=1HX	
UPPEK(I)=I/53 PROBLE(I)=454 00 15 J=1+7 15 \$I(I,J)=455(J) IF (456+EQ.1HI) \$I(I,L)=1HX IF (456+EQ.1HN) \$I(I,C)=1HX IF (456+EQ.1HN) \$I(I,G)=1HX IF (456+EQ.1HU) \$I(I,G)=1HX IF (456+EQ.1HU) \$I(I,G)=1HX IF (456+EQ.1HU) \$I(I,G)=1HX	
QQ 15 J=1+7 15 \$I(I,J) = V55(J) IF (V56+EQ.1HI) \$I(I,L) = 1HX IF (V56+EQ.1HN) \$I(I,C) = 1HX IF (V56+EQ.1HN) \$I(I,3) = 1HX IF (V56+EQ.1HU) \$I(I,4) = 1HX IF (V56+EQ.1HE) \$I(I,5) = 1HX	
15 \$I(I,J) = V55(J) IF (V56.EQ.1HI) \$I(I,L) = 1HX IF (V56.EQ.1HN) \$I(I,Z) = 1HX IF (V56.EQ.1HN) \$I(I,Z) = 1HX IF (V56.EQ.1HU) \$I(I,Z) = 1HX IF (V56.EQ.1HS) \$I(I,Z) = 1HX	
IF (V56.60.1AT) SI(I,1)=1HX IF (V56.60.1HN) SI(I,2)=1HX IF (V56.60.1HN) SI(I,3)=1HX IF (V56.60.1HU) SI(I,4)=1HX IF (V56.60.1HS) SI(I,5)=1HX	
(
IF (456.60.1HU) SI(I.4)=1HX IF (456.60.1HE) SI(I.5)=1HX	
IF (456-60-1HE) SI(I+5)=1HX	
IF (V56.60.144) SI(I.61=1HX IF (V56.60.140) SI(I.7)=1HX	
LOC(I)=158	
SIG(I)=V59 LIYP(I)=IVoC	

#ULTLA(I)=IV61 C INCREASE COUNTER G I=I+1 C #AD FILE G #AD FILE G #AD (IN,3+) I/\$1,1/\$2,1/\$3,/\$4,(V\$5(LI),II=1,1/\$0,V\$61 G G#ACK FOR EX)=OF=FILE G IF (EOF(IN)) 32,13 C DATA ENTRY MAS CARLIER LAUNCH G 16 IDATE(I)=IV11 DOUST(I)=IV12 UPPER(I)=IV13 PRODUR(I)=V14	F F F F F F F F F F F F F F F F F F F
C INCREASE COUNTER C I=1+1 C AEAD FILE G AEAD (IN,3m) L+51,1+52,1+53,454,(V55(LI),II=1,1+50,IV61 G CHECK FOR EH)=OF-FILE G IF (EOF(IN)) 32,13 C OATA ENTRY HAS EARLIER LAUNCH C 16 IOATE(I)=IV11 300SI(I)=IV12 UPPER(I)=IV13 PRODIR(I)=V14 17 SI(I,J)=V15(J) IF (V16+EQ,1HT) SI(I,J)=IHX IF (V16+EQ,1HT) SI(I,J)=IHX	F F F F F F F F F F F F F F F F F F F
C G G G G G G G G G G G G G	F F F F F F F F F F F F F F F F F F F
I=I+1	F F F F F F F F F F F F F F F F F F F
G READ FILE G READ (IN,30) I/51,1/52,I/51,1/54,(V55(LI),II=1, 1/60,IV61 G GHECK FOR EX)=OF=FILE G IF (EOF(IN)) 32,1/3 G OATA ENTRY MAS CARLIER LAUNCH G 16 IDATE(I)=IV11 900\$I(I)=IV12 UPPER(I)=IV13 REODIR(I)=V14	F F F F F F F F F F F F F F F F F F F
G AEAD (IN,34) I+51,I+52,I+51,+54,(+55(11),II=1, 1+60,I+61 G G GHECK FOR Ex)=OF=FILE G IF (EOF(IN)) 32,13 G OATA ENTRY MAS CARLIER LAUNCH G 16 IDATE(I)=I+11 900\$I(I)=I+12 UPPER(I)=I+13 PRODER(I)=V14	F. 7), 456, 457, 458, 459, I F F F F F F F F F F F F F F F F F F
1/60, IV61 G CHECK FOR EX)-OF-FILE G IF (EOF(IN)) 32, 13 G DATA ENTRY MAS CARLIER LAUNCH G 16 IDATE(I) = IV11 900SI(I) = IV12 UPPER(I) = IV13 PRODER(I) = IV14	F F F F F F F F F F F F F F F F F F F
1/60, IV61 G CHECK FOR EX)-OF-FILE G IF (EOF(IN)) 32, 13 G DATA ENTRY MAS CARLIER LAUNCH G 16 IDATE(I) = IV11 900SI(I) = IV12 UPPER(I) = IV13 PRODER(I) = IV13 PRODER(I) = V14	F F F F F F F F F F F F F F F F F F F
G GHECK FOR EX)=OF=FILE G IF (EOF(IN)) 32,13 G DATA ENTRY MAS CARLIER LAUNCH G DATA ENTRY MAS CARLIER LAUNCH G 16 IOATE(I)=IV11 300SI(I)=IV12 UPPER(I)=IV13 RK00IR(I)=V1* 30 17 J=1,7 17 SI(I,J)=V15(J) IF (V16-cQ.1HT) SI(I,1)=1HX IF (V16-cQ.1HA) SI(I,2)=1HX IF (V16-cQ.1HA) SI(I,5)=1HX IF (V16-cQ.1HA) SI(I,5)=1HX IF (V16-cQ.1HA) SI(I,5)=1HX IF (V16-cQ.1HA) SI(I,5)=1HX	
G IF (EOF(IN)) 32,13 C DATA ENTRY MAS CARLIER LAUNCH 16 IDATE(I) = IV11 300SI(I) = IV12 UPPER(I) = IV13 RK00IR(I) = VI4	
G DATA ENTRY MAS CARLIER LAUNCH G 16 IDATE(I) = IV11 900SI(I) = IV12 UPPER(I) = IV13 RK00IR(I) = V14	
G DATA ENTRY MAS CARLIER LAUNCH G 16 IDATE(I) = IV11 900\$I(I) = IV12 UPPER(I) = IV13 PRODER(I) = V14	
G 16 IGATE(I) = IV11 900SI(I) = IV12 UPPER(I) = IV13 PRODER(I) = V14	F
16 IDATE(I) = IV11 900SI(I) = IV12 UPPER(I) = IV13 PRODIR(I) = V14	
### ##################################	F
### ##################################	F
17 ST (1, J) = V15 (J) IF (V16, dQ, 1HT) ST (I, 1) = 1HX IF (V16, EQ, 1HN) ST (I, 2) = 1HX IF (V16, EQ, 1HN) ST (I, 3) = 1HX IF (V16, EQ, 1HU) ST (I, 4) = 1HX IF (V16, EQ, 1HH) ST (I, 6) = 1HX IF (V16, EQ, 1HH) ST (I, 6) = 1HX	
- IF (V16-EQ-1HN) ST(I,2)=1HX - IF (V16-EQ-1HN) ST(I,3)=1HX - IF (V16-EQ-1HU) ST(I,4)=1HX - IF (V16-EQ-1HE) ST(I,5)=1HX - IF (V16-EQ-1HH) ST(I,6)=1HX	
IF (V16.EQ.1M3) ST(1,3)=1HX IF (V16.EQ.1MU) ST(1,4)=1HX IF (V16.EQ.1ME) ST(1,5)=1HX IF (V16.EQ.1MH) ST(1,6)=1HX	
IF (V16.cQ.1MU) ST(I,4)=1HX IF (V16.cQ.1HE) ST(I,5)=1HX IF (V16.cQ.1HH) ST(I,6)=1HX	
IF (V16. EQ. 1HE) ST(1,5) = 1HX IF (V16. EQ. 1HH) ST(1,6) = 1HX	
IF (V16.EQ.1HH) ST(I.6)=1HX	F
IF (V16. 20.1 HO) ST(1.7) = 1 HX	F
	<u> </u>
+0C(I)=V18	
\$76(1)=19	F
MULILA(I)=IV21	
C INCREASE COUNTER	
C	
I=I+1	F
CCAR FILE	
ACAU PLLE	
READ (10.5+) [V11. [V12. [V15. V14. (V15([I) . [I=1.	
C CHECK FUR END-OF-FILE	
C GHECK FUR END-OF-FILE	
LF (EOF(IO)) 31.13	
LF (EOF(IO)) 31,13	F
CHECK FOR THE SAME HOOSIER VEHICLE	
18 IF (IV12-IV52) 10-19-14	
2	F
C CHECK FOR THE SAME UPPER STAGE	F
19 [F (+V13=[V53] 10-20-19	F

OUTINE 4	ENHER 74474 327-1 FIN 4,64433	0.8
	CHECK FOR THE SAME PROJECT DIRECTOR	
	20 IF (V14=V54) -10+21+14	
<u>c</u>	CHECK FOR MULTIPLE LAUNCH OF SAME VEHICLE	
- 6	21 IF (IV21-IV61) 15-22-14	
	C1 1 1 1 1 C1 1 1 O 1 1 O 1 C C 1 1 1 O 1 C C 1 1 1 O 1 C C 1 1 O 1 C C C C	
	COMBINE THE DUPLICATE INFORMATION INTO A SINGLE ENTRY	
G		
	22 IDAI54I)=IV11	
1		-
	UPPER(I)=IV13	
	90 23 J=1.7	
	IF (V55(1), Nc. 14) SI(I, 1)=V55(1)	
	23 CONTINUE	
	IF (V16+EQ+1HT+) 37+V56+EQ+1HT) ST4T+11=1HX	
	IF (V16.cq.1HN. 32.V56.EQ.1HN) SF(I.2)=1HX	
	IF (V16. eQ.1HB. D2. V56. EQ. 1H3) ST(1,3)=1HX	
	IF (+16. 20. 1HU-UR-+56. EQ-1HU) ST(1,4)=1HX	
	IF (V16, EQ.1HE, 3R. V56, EQ.1HE) SI(I,5)=1HX	
	IF (V16, eQ, 1H0, QR, V56, EQ, 1H0) - SI (I, 7) = 1HX	
	RESCIT - THS	
	IF (417-EQ.1HF.32-457-EQ.1HF) RES(I)=1HF	
	IF LV18. NE. 1H 1 LOC(I)=V18	
	STG(I)=1H	-
	IF (V19.NE.1H) STG(I)=V19 	
	IF (1421 No. 6) 148(1)=1420	
	IF (IV6) MEVOL VIYP(I)=IV60	
	MULTLA(I)=0	
	IF LIV21.NE.C) MULTLACIJ=1421	
	IF (IV61.NE.C) MULICALLI=IV61	
č		
c	LNUREASC LUUNICE	
•	Lalet	
C	READ FILE	
G		
	REAJ (IN.34) LYS1-1152-1453-454-1455(11)-11=1-7)-456-457-458-459	1+I
	1460+1461	
	CHECK FOR END-DE-FILE	
	THE LA FURE AUGUST PROFILE	10
	LE (EOF(IN)) 32,24	
c		
C	CHECK FOR DUPLICATE ENTRY	
	.24 IF (IDAT:(I=1)-[V51] 34.25.30	

UTINE RE	MER 74/74 OPT=1
	25 IF (800)7(1-1)-1+52) 30,26,30
	26 IF (UPPER(I-1)-1453) 30,27.30
	77 IF (PRODIN(I-1)-V54) 36.28.30
	28 IF (MULTLA(I-1)-1461) 30,29,30
-	26 18 18UL+LA(1-11-1461) 34-29-34
	29 t=t-1
	60 10 35
	ACAD FILE
	30 READ ([].]4) [\11.[\12.[\13.\14.(\15([]).[[=1.7].\16.\17.\18.\19.[
	1420,I421
•	
	CHECK-FOR ENJ-OF-FILE
	IF (50F(I0)) 31,13
<u> </u>	CHECK OUPLICATE FILE INCICATOR TO SEE IF BOTH END-OF-FILE MARKS
C	HAVE BEEN READ
G	
	31 IF (IFLAG. NE. 0) 60 TO 33
G	
	- USEO
	0020
a company of the contract	
C	
G	SET BUPLICATE INDICATOR TO ONE TO INDICATE THAT ONE ENG-OF-FILE
G -	MAS 942 N 284)
C	
	IFLAG=1
•	
	- AEAO FILE
	ACAU FILE
	READ (10-34) IV11-IV12-IV13-V14-(V15(IL)-II=L-71-V16-V17-V18-V19-I
	142 + I 421
C	
- c.	CHECK FUR END-OF-FILE
Č	
	IF (EOF(IO)) 33-13
G	
	CHECK OUPLICATE FILE INDICATOR TO SEE IF BOTH END-DE-FILE MARKS
	HAVE BEEN READ
G .	
	32 LF LIFLAG.NE. 01 GO TO 33
	CHARGE WHAT OF CITE OF THE CITE TO THAT ONLY ONE CITE TO COTTO
C -	CHANGE NUMBER OF FILE BEING READ SO THAT ONLY ONE FILE IS BEING
	4380
	SET HUPLICATE INCICATOR TO ONE TO INDICATE THAT ONE END-OF-FILE
	HAS BEEN READ
	IFLAG=1
2	
0	ACAD FILE

	READ (IN.34) IV51, IV52, IV53, V54, (V554IL), II=1,71, V56, V57, V58, V59,
	1460,1461
	C
	C CHESK FUR =N3-OF-FILE
	G
	G
	G SET *ORGOAT* EQUAL TO THE NUMBER OF ACTUAL DATA ENTRIES IN THE
	C HAIN DATA SILE
	c
	33-0R60AT=I-1
	6
	G RETURN CONTROL- FO MAIN PROGRAM
	- AETURN
	G
	C FURMAF SFATEMENTS
	C. FORTHAT STATEMENTS
	<u> </u>
	The state of the s
*	
	the state of the s
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-	

	NGE 74/74 OPT=1 FIN 4.5+433 G
	SUBROUTINE CHANGE (IVI)
6	303,007112 011101
6 —	- TYPE STATEMENTS
Ğ -	TV B OVER COLOR
•	REAL LOG
	INTEGER ORGOAT
	INTEGER GOST-UPPER
•	TH! FOCK - 00001 AND ECK
	COMMON ALOCKS
	SUMUN 160043
	GUNNON / DATAIN/ ORGUAT, NEHDAT, IDATA(2000) -BUOST(2000) -UPPER(2000)
	COMMUN / DAI ALMY ORGULAL NEWS I LIBRICI 2000 ASSOCIATION OF PER 12000 A
	150UR(2000), RES(20JU), LOC(2000), PROUIR(2000), ST(2000, 7), ST6(2000) -L
	27YP120031, HULTLA120001, ALN
	THIS SUBROUTINE USES A DUMMY VARIABLE SCR. TO SHITCH ENTRY FLA
	SCH=IDATE(J)
	13) 37A03=(L) 37
	IOATE(I)=SCR
	SCR=9005 F(J)
	BOOST (I) = SC9
6	
	SCERIPPE24 II
	UPPER(I)=SCR
_	
G	SC=50U2(J)
	- SOU+(J) = SOU+(I)
	SOUR(11)=SCR
^	3004-11-364
	SCH=RESLU
	463-6-3-6-4
· · · · · ·	
	- SCR=LOCIJI
	LOC(I) = LOC(I)
	-LOC(I)=SGR
	SCH=PRUDIR(J)
	PRODIR (J)=PRODIA(I)
	PROJIR (11=SCR
	30 1 K=:+7
	SCR=ST(J+K)
	SI (J-K) = SI (I-K)
	1 ST (L-K)=SCK
-	4.1372=932
	STG(J)=STG(I)
	SIG(I)=SCR
	SCE=LIYP(J)
	LIYPLUSLIYP(I)

SUB-COUTINE CH	ANSE 74474 Jaret	FTN 416+433	99/2
			F
			F
			E
	MULTLA (I)=SCR		F
	TOCHCA (1) POUR		
	RETURN		F
			F
1.			

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			11-4
	and the second s		
	CONTRACTOR OF THE CONTRACTOR O		
		and a second	
		The second secon	

DUTINE	/ENIGLE 74/74 OPI=1 FIN 4-3+433
-	SUBRUUTINE VERICLE
	TYPE STATEMENTS
5	
	INTEGER SUCC.FAIL
	TMT-GER OR OAT
	INTEGER 300ST-UPPER-84-UV-441-U41-842-UV2-ALN
	- REAL LOC
	JIMENSION V5(7)
	COMMUN 3LOCKS
6	CONNUN SECRE
	2TYF(2000), MULTL4(2008), ALN
- · · · · · · · · · · · · · · · · · · ·	
	1-uGONF(24)-RESULATYP(6)
	- COMMON /STORIT/ SUCCI1560) FAIL(1500) RAT(1500) HEAD(12)
•	
	BLANK THE HEADING ARRAY
C	
	00 1 T=1,12
	1 HE AO(I)=10H
E	
G	FILL THE HEADING ARRAY
G	
	F (84.23.4.ANJ.U4.23.6) HEAD(1)=13H4LL LAUNCH
	TE (BY TO AND IVE TO A) HE AD (2A = 1 THVEH [CL - S
	-IF 484.NE.9) HEAD(1)=84EH(84)
	IF (UV-NE) HEAD(2)=UVEH(UV)
	TE THE NE OF HEADEST SECURITARY
	IF TUY. NE. +) HEAD (4) =UCONT (UV)
	IF (8V1.NE. 4) 4EAD(5)=8VEH(8V1)
	IF (BV1.NE.U) HEAC(7)=BCONT(BV1)
	TE (UV1.NE.D) HEAD(8) =UCONF(UV1)
	IF (RV2.NE.01 HEAD191=8VEHLdV2)
	IF (UVZ.Ne) HEAD(IG)=UVEH(UVZ)
	IF (342.NE.0) MEAD(L1)=8CONT(842)
	IF (UV2.NE. 0) HEAD(12)=UCONT(UV2)
	ZERO INDEX FOR VEHICLE ARRAY
6	CERU LAUGA F JX VERLUCE ARRAY
-	
G	A CONTRACTOR OF THE PROPERTY O
	- TEST CACH ENTRY IN MAIN DATA FILE TO DETERMINE IF IT MEETS
- C	OUTPUT SPECIFICATIONS ON VEHICLE TYPE AND LAUNCH RESULT
	30 6 I=1 .0RG3AI
	11/1-11/1-14/14-14-14-14-14-14-14-14-14-14-14-14-14-1
	ISI FOR END-OF-FILE

HITTHE AG	HIGLE 74/74 OPF=1 FFN 4.6+433
G	TEST FOR VEHICLE TYPE TO BE DUTPUT
· .	IF *BV * AND *UV * ARE BOTH ZERO. DUTPUT ALL VEHICLES
	LE SAVE DE SURE NOT COURT 7550. THEN OUTPUT ONLY DESIRED
	VehICLes
G	
	2 IF (3V-2Q-0-AND-UV-2Q-0) GO TO 4
	IF -(IV2+EQ-84+03-IV2+EQ-8V1+0R-IV2+EU-8V2) GO TO 3
	IF (1143.EQ.UV. 3R. 143.EQ. UV1. OR. 143.EQ. UV2). AND. 8V. EQ. C1 GO TO 4
	60 10 6
	3 IF (UV. = Q. U) 60 TO 4
	60 10 6
- C	
	4 IF (RESULES 2N F.AND. 47. NE. 1HF) 63 T3 6
	IF (HESU-EG-2H F-AND-BV-EQ-D-AND-UV-NE-D-AND-V9-NE-1HU) GO TO 6
	IF TRESULED 24 F AND 84 NE O AND 14 . O O AND 49 NE 1481 GO TO 6

	- INCREMENT VEHICLE ARRAY INDEX AND FILE WEMICLE ARRAY
-	- INDEED 1 42710 EE 484 AT 1100 A 480 F 16 F 16 T 16 B 484 AT
	800ST(J)=IV2
	UPPER(J)=[+3
	5 ST (J,K)=45 (K)
	-RcS(H)=v7
	-STG(J1=49
	-
	AL No.
	6 CONFINUE
	REHINU THE MAIN DATA FILE
G	
	REHIHD 8
C	
- G	IF NJ FAILURES HAVE BEEN FOUND TO FILL THE ARRAY A MESSAGE IS
C -	PRINTED AND CONTROL IS RETURNED TO THE MAIN PROGRAM
C -	
	-IF (J.GI.0) GO TO 7
	PRINT 16.
	2FTUPAL
G	
	THE VEHICLE ARRAY IS PRINTED AFTER SEPARATING THE DATE INTO
	- AONTHADAYAY (A)
15	7-00 9 (=1 -ALN
	LUZ=IOA(ELL)-[J1*100-[D3*1-00C
	IF (MOO((I-1),531, Nc. 01, GO TO A
	IF (BESU EQ. 2H E) 48 (FE (6.12)

SUBMOUTINE VEHICLE	74/74 027=1	FTN 4.5+433 88/
#811	FE (6+13) ME40	F
4011	r: (6 14)	
	16 16 161 101 102 103 - 2VEH1 dOOST (11)	.UVEH(UPPER(I)), PROCIR(I), (F
	I-J), J=1,71,LATYP(LTYP(I)), RES(I),ST	G(I), LOC(I)
ć	RETURN CONTROL TO THE MAIN PROGRAM	
6		
- RET		
G	T. 111	
	FORMAT STATEMENTS	
	PURMAT STATEMENTS	
•		
10 FOR	MAT - (1H1)	
	MAT - 1740 - 25 HT OFAL - VEHICLE HISTORY FO	
	HAT (T40, 18HFOTAL FAILURES FOR)	
	MAF (34T40+410+2x+410/742+416+2X+416	///
	MAT (T4,4HDAFE,F12,7H800STER,T24,11H	WPP-1 STAGE T39 , 16 HPROJECT
	ECTOR TOS 21 4SOURCE UF INFORMATION T	194.6HLAUNCH, T114.7HFAILURE/
2754	JSHTRH MASA BY UV LIR HIR OT	HER, 196, 13HTYPE RESULT, T1 F
	ISHETAC LICATIONAL	
15 500	MAT +1X+12+1+/+12+1+/+12+112+AL0+124	++A16+143+A4+159+A1+164+A1+T
tag.	AL, F74, AL, F38, AL, F35, AL, F39, AL, F35, A	6-F1-5-41-F113-A1-F121-A11-
16-503	MAT (1H1.TS5,30HNO FAILURES HAVE BEE	N REPORTED!
17 500	MAT (16,212,44,1141,211)	
		
-	The second secon	
	And the second s	
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SUBROUTIN	FAILRAT 7+/74 OPT=1 FIN 4+0+433	_ 08/
	SUBROUTINE FAILRAT (NO)	
	G IYPE STATEMENTS	F
	G	F
	INTEGER ALN, dV, UV	
	INTEGER - 041,342,UV1,UV2	F
	C COMMON BLOCKS	
	G	2) + F
	COMMON /DATAGUT/ BV.UV.BV1,UV1,BV2,UV2,BVEH(20),UVEH(20),BCONT(201_F
	G	
	COMMON /STORIT/ SUCC(1500), FAIL (1500), RAT (1500), HEAD(12)	
	G ZERO THE SUCCESS AND FAILURE COUNTERS	
	6 00 -1 I=1-ALN	
-		
	-1 FAIL(I)=)	
	G	
- 100-	IF (NO. = 2-0) NO1=ALN	
	E (NO.UT.C) NOL = NUL	6
	C. THE NUMBER OF SUCCESSES AND FAILURES ARE CALCULATED	
	G THESE MAY BE THE TOTALS TO THE LAUNCH BEING CONSIDERED OR ON	L¥
	C A FAILURE OF THE BOOSTER WHEN THE UPPER STAGE IS THE DESTREE	
	C VEHICLE RESULTS IN A NO-TEST CONDITION FOR THE UPPER STAGE	
	G	
	96 4 I=1 vALN	
enganismo e anima e e e	IF (I+J. of ALN+11 GO TO 3	
	IE (SIG(I) EQ. LHU. AND. UV. NE. O) GO TO 2	
	IF (STG(I).EQ.143.ANO.8V.EQ.U.ANO.UV.NE.U) 50 TO 3	
·	C INCREMENT THE SUCCESS CHUNTER	
	SUCC(I+J=1)=SUCC(I+J=1)+1	
	-0 TO 3	
	G INCREMENT THE FAILURE COUNTER	
	2 FAIL(I+J+1)=FAIL(I+J-1)+1	-
	AFTER EACH LAUNCH THE SUGGESS RATIO IS CALCULATED	
	RATILI-SUCCIO *100.0/ISUCCIO+FALLID	

SURRUUTINE FAI	124T 74/74 0PT=1 FTN 4:6+455 UH/
	F (NC+LT+++++++++++++++++++++++++++++++++++
_	IF A RUNNING TALLY IS REQUESTED IT IS PRINTED AT THIS POINT F
	IF (400(11-1)-50)-E0-0) HRITE (6.5) HEAD-NOL-ALN
	HRITE (6,6) I.RESCO, STECCO, SUCCOLO, FAIL (I) RATIO
	4 CONFINUE F
	21 11010C101 1C10K1
6	IF ONLY A SUMMARY IS REQUESTED IT PRINTED AT THIS POINT
	HRETE (5.7) NOL, ALM, SUCC (ALM), FAIL (ALM), RAT (ALM)
	RETURN CONTROL TO THE MAIN PROGRAM
	Re TURN F
	FORMAT STATEMENTS
-	
	5 FORMAT (1H1,3(F++,A10,2X,A14/T+2,A10,2X,A1+/)//T8,51HABJUSTED CUMU F - LLATIVE SUGGESS/FAILURE RATIO FOR LAST +I++23H FLIGHTS OF A FOTAL O F 2F ,I+//T10,13HLAUNGH NUMBER,T27,6HRESULT,T35,5HSTAGE,T47,6HTOTALS+ F ITS8,8HPER GENT/I+7,145,T52,1HF/)
	FORMAT (115-14-130-A1-138-A1-145-14-150-14-158-F6-2) FORMAT (111-18-4-14-138-F6-2) FORMAT (111-18-4-14-138-F6-3-14-234-F
	IFLIGHTS OF A TOTAL OF JIGATIO 22HNUMBER OF SUCCESSES - JIGATIO 22H F
	ZNUMBER OF FAILURES = +14/T10+14HRELIABILLTY = +F6+2+14///
*	ENO

	ILLOC 7+/74 3PI=1 FIN +.5+433 3
	SUBRUUTINE FAILLUC (NO)
G.	
c	TYPE STATEMENTS
- G	
	- INTEGER FL.FR.FA.FO.FAIL.ALN.BV.UV.SUCG
	INT. CER BY 1, 3V2, UV1, UV2
	JEAL LEAT
C -	
Č	CUMMON BLOCKS
6	
	- COMMON / UATAIN/ URGOAT, NEHOAT, IDATE(2000) - 3005T(2000) - UPPER(2000) -
	150Ux (2001) RES(200) LOC(200) PRODIR(200) ST(200,7) ST6(2010) L
	2740 (2005) AULTLA (2000) ALN
C	
	COMMON / UATAOUT/ 8V . UV . 8V1 . UV1 . 8V2 . UV2 . 8VEH (201 . UVEH(201 . 9CONT (201
	1,UCONT (20) ,RESU,LATYP(6)
C	COMMON /STORIT/ SUCC(1500), FAIL(1500), RAT(1500), HEAD(12)
	COMMON /STORIT/ SUCC(1500), FAIL(1500), RAT(1500), HEAD(12)
· G-	
- 6-	ZERO THE FAILURE LOCATION COUNTERS
	EL = A
	FP = U
	F4=1
	F0=0
	PU39
G	SET THE STARTING LAUNCH NUMBER
	SET THE STARTING LAUNCH NUMBER
- G -	
-	NO1=NO+4LN/1+0+3
	LF INO. COUNTY NO. 1 PLAN TO THE STATE OF TH
	N1=ALN=NU1+1
- C	
	THE FAILURES DURING EACH PHASE ARE NOW CALCULATED
C	IF THE PHASE OF FAILURE IS UNKNOWN THAT LAUNCH IS NOT INCLUDED
Č	
•	30 2 I=+1.ALN
	IF (SIG(I)-EQ-148-AND-84-N2-3) SU TO 1
	- IF -(STG(I) -61-14U-AND-UV-NL-0) GO TO 1
	IF (34-2-5-AN)-UV-EQ-0-ANC-RESIII-EQ-1HF1 30 TO 1
	-60-10-2
	1 IF (LOC(I) +CQ. LHP) FP=FP+1
	IF (LOC(I)-EQ-14A) FA=FA+1
-	IF (LOC(I)-£0-140) E0=E0+1
	2 CONFINUE
G	CALCULATE THE TOTAL NUMBER OF FAILURES
G	CALCULATE THE TOTAL NUMBER OF FAILURES
<u> </u>	IF NO FAI UP-S ARE FOUND, RETURN TO THE MAIN PROGRAM
<u>c</u>	
	FALL(1)=EP+FL+FA+FU
	LE (FAI-(1) 1) RETURN
Ç	CALCULATE THE PERCENTAGE OF FAILURES OGGUREING DURING EACH
`	CALGULATE THE PERGENTAGE OF FAILURES OCCURRENCE DURING EACH
C	PHASE
	PRAT=EP*18(/FAL-(;)

SUBROUTINE	E F4[tc06 74/74 92f=t	+433	03/2
	LKAT=FL*18G.J/FATL411		F
	48AT=FA*100.0/FATL(1)		- F
	28AT-F0*100.3/FATL(1)		E
	6		F
	C PHINT THE RESULTS		- F
	HRITE (6.3) HEAD, NOL, ALN, FP, PRAT, FL, LRAT, FA, AKAT, FO, O	RAT, FAIL (1)	F
	C RETURN CUNTROL TO THE MAIN PROGRAM		
	S — NETURN		F
	C FORMAT STATEMENTS		_ F
	G G G G G G G G G G G G G G G G G G G		F
	G 3 FORMAT (1H1,3(F+0,A10,2x,A10/F42,A10,2x,A10/)//F8,47H	A TOTAL OF , 3MPAJ, [32, [3 13, [49, F6.2/ H100.00)	1 6
	4 FORMAT (/// T35,30 HNO FAILURES HAVE BEEN REPORTED)		£
	ENO		
			-
-			
			11.18
No. 1			
-			
	The second section of the second section of the second second section of the second section of the second section sect		
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			179171

	- SUBROUTINE CURVIT (NU,C1,C2,C3,C4)
	- GORNOALTIC - GARAT ! (MOTE TO CLOSE) CO.
	TYPE STATEMENTS
	INTEGER C1-62-63-64
	INTEGER ALM. SUCC. FAIL
G-	
c_	COMMON BLOCKS
C	
	150UR(2004)-x25(2006)-LOG(2000)-PRJOIX(2000)-ST(2000-7)-STS(2000)-L
	2TYP(2001),MULTL4(2000),ALN
G -	
	GOMMON /STORIT/ SUGG(1500) FAIL(1500) FRAT(1500) HEAD(12)
-	COMMON FITT - X (2000) , Y (2000) , WF (2000) , HORK (2500) , THEOR (2000) , NDATA
	1, RELERR, AdSERR, IFLAG, PARISI, R, NPAR
 -	EXTERNAL THOSE SUBROUTINE NAMES WHICH ARE USED IN CALLS TO
	OTHER SUBROUTINES
	THEORI- THEORS- THEORS- THEORY CONTAIN THE EQUATIONS THAT
- 6	ARE TO 32 FIF
	DERIVITA DERIVE, DERIVE, DERIVE CONTAIN THE FIRST AND SECOND
- 5-	PARTIAL DERIVATIVES OF THE CORRESPONDING THEOR SUBROUTINE
- 6	
	EXTERNAL THEORI, DERIVI, THEOR2, DERIVE, THEOR3, DERIVS, THEOR4, CERIVA
- C	- DATA BLOCK SETS THE VALUES OF THE ERROR TEST FOR THE CURVE
C	FITTING SUBSCUTINES
-	F111 140 3054U11463
9	04/4 RELERR/1-6-4/-48SERR/1-E-6/
_	AND ACCEPTABLE TO SECURITIES OF
G	DETERMINE THE NUMBER OF LAUNCHES TO BE CONSIDERED
	DE LEGIT HE THE TOTAL TOTAL OF CONSTRUCT
. 6	- NO 1 = NO * AL N/1 + C - A
G	
G	- FILL THE TAT ARRAY WITH THE LAUNCH NUMBER LAUNSTED TO THE NEW
0	START
C	FILL THE TYP ARRAY WITH THE ACHIEVED RELIABILITY
c	- FILL THE THET ARRAY WITH ONES SO ALL LAUNCHES ARE CONSIDERED
C	EQUALLY
C	
.,	30 L I=1.Nu1
	Y / T > - T
	- * (I) = KAT (I + AL N - NO 1)
	#F(I)=1,1
	1 CONTINUE
-	
G	T ANDATAL - NUMBER OF LAUNCHER
- 0	- SET *NDATA = HUMBER OF LAUNCHES
G	SET +NPAR+ = NUMBER OF CURVE FIT PARAMETERS
C	
	NOATA=NU1
	NPAR=3
(*	
6	TEST FOR FIT ON Y = A + 3 * EXP(C * X)

	RVLT 7+/74 73F31
	IF (C1.Nc.1) 63 TO 2
	SET INITIAL SUESS ON PARAMETERS
	P4x(1)=i.0
	PAR(2)=-1.J PAR(3)=-0.5
	-IFLAG=0
-	CALL CURVE FITTING SUBROUTINES
-6-	GALL GURYE TITTO GOMOVITA
	CALL FITT (THEORI, DERIVI)
	IF (IFLAGOC Go Lot 60 TO 2
	Th (Thrane Garan and Angel
- 5	- HRITE EQUATION HITH CALCULATED PARAMETERS
	4.1.1.2.6.3011.101
	HRITE (6,5) PA-(11, PAR(21, PAR(3)
•	HREIC COSOS PROCEST STREETS AND
	TEST FOR FIT ON Y = A * EXP(8 * EXP(C * X))
	1651-104-11-104-11-104-11-104-11-11-11-11-11-11-11-11-11-11-11-11-11
	2 IF (G2.NE.1) GO TO 3
	- 2 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4
· S	SET INITIAL GUESS ON PARAMETERS
C	251 FHITTHE GOSSO ON A MANUEL STA
	244(1)=1.0
	PAF(2)==1,0
	946(3)==1.0
	IFLAG=0
G	CALL CURVE FITTING SUBPOUTINES
•	CALL FILLT (THEORE, DERLY2)
	IF (IFLAG. cQ-14) 50 TO 3
G.	
	WRITE EQUATION HITH CALCULATED PARAMETERS
	4RIFE (0.7) PAR(1) . PAR(2) . PAR(3)
c	
-	IGST FOR FIT ON Y = A + (1 - 8/(5 + X + 3))
,,	3 IF (C3-N1) GO TO 4
•	
	SET INITIAL GUESS ON PARAMETERS
-	- SEL - 1111 FAC 500-15
•	208(1)=1.0
	PAR(2)=1.0
	PAK (3) = 1+0
	IFLAG=0
3	CALL CURVE FITTING SUBROUTINES
	CALL FITIT (THEORS, DERIVS)
-	LE (IFLAGQ.12) SQ TO 6
_	
	HRII- EQUATION HITH CALCULATED PARAMETERS
	AKIS: (6.8) PAK(1).PAR(2).PAR(3)

SABKOALTNE	CURVIT 74/74 OPT=1
	6
	G TEST FOR FET UN Y = A * EXP(3/X)
	4 IF (C4.NE.1) 60 TO 5
	S SET INSTIAL SUESS ON PARAMETERS
	G PAR(1)=1.3
	PAR(2) == 0.5
	G GALL GURVE FIFFING SUBROUTINES
	CALL FILLI LINCORA DERIVAL
	IF (IFLAGRED-13) 60 TO 5
	£
	C HRITE EQUATION HITH CALCULATED PARAMETERS
	#RITE (6+3) PAR(1)-PAR(2)
	5 CONTINUE
	6
	C RETURN CONTROL TU MAIN PROGRAM
	RETURN
	6
	S FORMAT STATEMENTS
	c
	C
	6 FORMAT LIHI, 43 HINE CURVE FIT FOR THIS DATA IS OF THE FORM 1//10 X, www.
	14RELIABILITY A EEXP(C-+ LAUNCH NUMBER) / /2X + 39HHITH THE PARA-
	2METERS 4, U+ 3 45 FULLOHS://15X,3HA =,e18.10/15X,3HB =,E18.10/15X+
	33HC = 7E18-16/1
***	-7 FORMAT (1H1,43+THE CURVE FIT FOR THIS DATA IS OF THE FORM://10x,49
	2 PARAMETERS A. J. C AS FOLLOWS: //15x, 3HA =, E18.10/15x, 3HH =, E18.10
	3/15X,3H0 = +E19+10/1
• •	# FORMAT LIHI, 43 HIHE CURVE FIT FOR THIS DATA IS OF THE FORM : // 10 4.43
	THRELIABILITY = A + (1 - B/IC + LAUNCH NUMBER + 31) // 2X . 39HHITH THE
	2 PARAMETERS A. 3. C AS FULLOWS: //15x.3HA =.:18.10/15x.3HB =.:18.10
	3/15x,3HC =,618-11/1
	9 FORMAT LIHI, 43 HTHE CURVE FIT FOR THIS DATA IS OF THE FORM://1CX.38
	THRELIABILITY = A + EXP(B/LAUNCH NUMBER) // 2X, 36HHITH THE PARAMETERS
	2 A. A AS FOLLOWS: //15X,3HA == £18-10/15X,3HB == £18-10/1
	= NO

SUBROUTING THEO	R1 74/74 - OPT = 1 FIN 4.64433
	-SUBROUTINE THEOR1 -SOMMON FFITE X (2000) + Y (2000) + HF (2000) + HORK(2500) + THEOR(2001) + NOATA
	-SOMMON FFITE X (2001) + Y (2004) + H (2004) + HORK123444 + IMEOR12444 + NUM + N
	1, RELERRY ABSERR, IFLAC, PAH (6) , R, NPAR
	-00 2 I=1-NJAFA
	CHECK FOR POSSIBLE EXPONENTIAL ARGUMENT OUT OF RANCE
	CHECK FUR MOSSIBLE EXMONENTIAL ANGUNERY OUT OF RANGE
	IF (PAR(3)**(I).5c,-670.ANJ.PAR(3)**(I).LE.735) GO TO 1
	48175 (673)
	IFLAG=1-
	FTHEN
	THEORY I) = PAR(1) + PAR(2) * EXP(PAR(3) * X(I))
	- CONTINUE
	RETURN
	FORMAT (1H1,45HEXPUNENTIAL ARGUMENT FOO LARGE FOR CURVE FIFE//2X+4
	-END
	AND THE RESIDENCE OF THE PROPERTY OF THE PROPE
	The state of the s
	COMPANY OF THE CONTROL OF THE CONTRO
	The state of the s
	THE CONTROL OF THE PROPERTY OF
	THE RESERVE OF THE RESERVE OF THE PROPERTY OF

SUBROUTINE DERIFT 74/7+ 32T=1 FTN 4.6+433 38/			
	SUDROUTINE DERIVI- (I,PF,PPF)		F
	T. MENSTON DE IST. PREIS . ST		F
	COMMON /FIT/ X120001, X120001, HF120001	HORK(2500) THEOR(2010)	NOATA F
	1.RELERR, ASSERT, IFLAG, PAR (6) -R. NPAR		E
	PF(1)=1,		F
	25 (2) = EXP(PAR(3) *X(I))		F
	PE (3)=X(1)+PAx(2)+PE(2)		F
	PRF (1-1)=0-0		F
	PRF (2-1) = 0-6		F
	PRF (3-1)=0-0		F
	2PF (1, 2) =PPF (2,1)		F
	PRF (2,2)=0.0		F
	PPF(3-2) =X (I) *PF(2)		F
	PPF(1-3)=PPF(3-1)		F
	PDF (2-3) =PPF (3-2)		F
	PPF(3,3)=X(1)+PF(3)		. F
	RETURN		
	END		F
	The state of the s		
	and the state of t		
	The second of the second consequences are the terminate and the second of the second o		
			-
**			
			- 1/1
		The state of the s	
			-

UBRUUTINE THEOR	2 74/74 OPT=1 FTN 4.54433 084
	SUBMOUTING THEORS
	COMMON (517/ V12306) V12463) W5123001 W08K125301 THEOR(2030) MUATA
	RELERY AUSERS IFLAC, PARISH, R. NRAR
	20 2 7-1 112474
	CHECK FOR POSSIBLE EXPONENTIAL ARSUMENT OUT OF RANGE
	CHECK FOR POSSIBLE EXPONENTIAL ARGUMENT OUT OF RANGE
	IF (EXPIPAR(3)**(1)).GE670.AND.EXP(PAR(3)*X(1)).EE.7351 60 TO 1
	WRITE (e.J)
	IFLAG=13
	JE TIIZN
4	IFLAG=13 AETURN IHLOR(I)=PAR(1)*=XP(PAR(2)*EXP(PAR(3)*X(I)))
	CONFINUE
	RETURN
	FORMAT LINE, 45HEXPONENTIAL ARGUMENT TOO LARGE FOR CURVE FITS//2X,4-
	ENO
	
AT RESERVED A DESCRIPTION OF THE PERSONNEL PROPERTY.	

SUBROUT INE DE	RIV2 74/74 OPT=1 FIN 4.64433 - 48
	SUBROUTING DERIFE (I, PF, PPF)
	DIMENSION PF(6), PPF(6,6)
	TOMMON /FIT/ X(2400), Y(2400), HF(2003), HORK(2500), THEOR(2030), NOATA
	1.RELERR, ABSCRR, IFLAG, PAR (6), R. NPAR
	- GALTI ALTON ALLON
	THE TOTAL PROPERTY OF THE PARTY
	PPF (3,1) =PF(3) / PAR(1)
	PPF (1, 2) =PPF (2, 1)
	PPF (1,3) = PPF (3,1)
	PPF(2,5)=PPF(3,2)
	PPF(3,3)=PF(3)*X(I)*(1+PAR(2)*A)
	AE TURN
	- IND

SUBAUUTINE TH	HEOR3 74/74 OPT=1 FIN 4.64433	
		E
	SUBROUTINE THEORS	CI NOAFA F
	1,RELERR, ABSERR, IFLAG, PAR (6), R, NPAR	
		F
	1 CONTINUE	
		F

SUBROUTINE DE	74/74 3PT=1 FIN 4.54433	08/2
		- F I
	DIME ISLUM FF(6) PPF(6,6)	- FI
	COMMON /FIT/ X(2000) -X(2000) -HF(2000) - HORK(2500) - THEOR(2000) - NO	ATA ET
	1, RELLER, AUSERR, SFLAG, PARISI, R, NPAR	EI
	A-DADITA WITH ADADITATION	EI
	A=PAR(3) *X(1)+PAR(2) PE(1)=1-PAR(2)/A	ET
	PF(1)=1-PAR(2)/A PF(2)==PAR(1)*PAR(3)*X(1)/A**2.0	FI
	PF (3)=PAR(1)*PAR(2)*X(1)/A**2.0	F1
	PPF (2, 1) =PF (2) /242(1)	
	MP1 (2, 1) 3P (2) PAR (1)	- FI
	PPF(3,1)=PF(3)/P4R(1)	
	PPF (1+2)=PPF (2+1)	FI
-	PPF(2,2) == 2,0=PF(2)/A	F1
	PPF (3,2) == (PF (2) *X(I)+PF (3))/A	F1
	PPF(1,3) =PPF(3,1)	
	PPF (2,3) =PPF (3,2)	F_I
		F
	METURN	F
	ENO	F
		-
	Approximate the contract of th	
_		
		-
-		
		-

SUBRUUTING THEORY 74/74 3PT=1	FIN 4.64433 08/
SUMMON /FIT/ X126601-Y120601-HF12600	++ORK(2500) +THEOR(2000) +NOATA F
Lynelerg, Adserg, IFLAG, PAR (6), R. MPAR	
· · · · · · · · · · · · · · · · · · ·	
C CHECK FOR POSSIBLE EXPONENTIAL AR	CUMENT OUT OF HANGE
EF (PARTEL/XTI) -Ge 676 - AND -PARTEL/X	(I) + L ± + 735) - 60 - F3 - 1
RETURN	
2 CONTINUE	F
RETURN	
3 FORMAT (1M1, 45H) XPONENTIAL ARGUMENT 184RELIABILITY = A - EXP(B)LAUNCH NUM	TOO LANGE FOR CULVE FITS//2K+3 F
Company to the Company of the Compan	
The second secon	
and the second s	
	and the same of the company of the same of
A SECURIT OF SECURITION OF SEC	
THE RESIDENCE OF THE PARTY OF A SECURITY OF THE PARTY OF	
The state of the s	
	The second secon

SUBFOUTINE DERIVA 74/74 OPT=1-	FIN 4.6+433	38/2
SUBROUTINE DEATH (I,PF,PPF)		F 1
DIMENSION PF(6), PPF(6,6)		- F 1
COMMON /FIT/ X(2000), Y(2000), HF(2000), HO	2 2 2 5 COL THEODI 20:01	NOATA ET
L-RELERR-ABSERR-IFLAG, PARLOL-R-NPAR	(NUAL F
THE LEAR HADE ARE LAW PARED FROM THE		
PF(1)=EXP(PAR(2)/X(I)) RF(2)=PAR(1)*EXP(PAR(2)/X(I))/X(I)		
(2) 1/(1) = PF(1-5) 799		
PRF(1,2)=PPF(2,1)		F
PRF(2,2)=PF(2)/X([)		F1
RE TURN -		- F1
The state of the s		
The street at the street of th		

74474 321=1	FIN 4.5+433 08/
SUBRUUTINE FITTE (THEORY, DERIV)	
	PROGRAM LIBRARY F
G AFML IDENTIFICATION - FITTI	
G AFHL CONTACT - FECHNOLOGY OLVISION	
C MATHEMATICS SECTION	
C - VARABLISHED IN LIBNARY -	
G - DATE OF LAST MODIFICATION -	
	ε
	F
- G - PROGRAMMER - GAPT, JAMES H. HEAD	F
USAF ACADEMY	F
C	<u> </u>
G MODIFIED FOR AFHL US	E BY LT. HENRY J. HAPP
G DESCRIPTION OF SUBROUTINE CALLING	ARGUNENTS
	INIS IN THE X AND Y ARRAYS TO
	THE Y BUT WATER TO THE TANK TH
G NPAR INPUT NUMBER OF PAKAMET	THE THE BAD ARRAY
G THEORY EXTERNAL SUBROUTINE HHC	TH DESTREE THE THEODESTICAL FIT
6 VALUES AT THE GIVEN X VAL	
C DERLY SALESTAL SUBSTITUTE HAL	CH DESTRES THE STORT AND SECOND
C PARTIAL DEPLUATIVES DE TH	E FIT EXPRESSION WITH RESPECT
C TO THE DAPAMETERS AT EACH	OF THE DATA POINTS.
APPIDER TO VACEA THORIT	DATA VALUES.
C - Y INPUT - ARKAY OF CRUINATE	DATA VALUES.
- AF INPUT AHRAY OF POSITIVE	HE-GHTING FACTORS FOR THE DATA. F
C RELEASE INPUT RELATIVE ERROR TO	LERANCE FOR PARAMETER CONVERGENCE F
C - ABSERR INPUT ABSOLUTE ERROR TO	LERANCE FOR PARAMETER CONVERGENCE F
G IFLAG INPUT/JUTPUT ON INPUT.	IFLAGE ALL PRINT INTERMEDIATE !
C TIERATION VALUES AS THE S	UBROUTINE CONVERGES, AS ALL AS
G STATEMENTS GIVING THE REA	SONS FOR NON-CONVERGENCE. ON
C JUIPUT, IFLAS IS AN ERROR	
C -0 CONVERGENCE NURMAL	
C =1 CONVERGENCE . RESIDU	
C PRECISION EFFECTS.	
C =2 SUSH BUNVERGENCE - R	ESTUAL IS GREATER THAN 0.9 TIMES
C =3 MAXIMUM NUMBER OF IT	
DOSCIOLE DIVENCENCE	RESIDUAL HAS REMAINED LARGER
THAN 10 TIMES THE SN	MALLEST RESIDUAL FUR NCOS
C III PAITONS	
C =5 POSSIBLE DIVERGENCE.	
C NULH HAS INCREASED B	Y A EACTOR UF 10 FOR THE LAST
C NCJ2S LIERATIONS	
C -6 POSSIBLE LOCAL MINIM	UM. HAXIMUM NUMBER OF CUT STEP
C LITERATIONS TAKEN.	and the same of th
Z _A MATRIX IS SINGULAR	THE EOR MULATION OF THE THEORY
C ANNOR DERIV SUBROUT	INES MAY HE INCORRECT.
C PAR INPUT/QUIPUT ARRAY OF P	PARAMETER VALUES. IN INPUT. PAR
C CUNTAINS AN INITIAL ESTIM	TATE OF THE PARAMETER VALUES. UN
C OUTPUT, PAR CONTAINS THE	AST VALUE OHTAINED BY THE
SUBROUTINE AS IT ITERATED	
C RES OUTPUT RESTOUAL JALUE.	
	DEK MUST BE DIMENSIONED AT LEAST

	Z*NPAR+12 + 3*NPAR + NDATA.
-	THE WAR THOUSE
<u> </u>	ARSTRACT
	- ABSTRACT
	SUBROUTINE FLILT FLTS A USER-PRESCRIBED FUNCTION OF ONE VARIABLE
	AND NPAR PARAMETERS TO A SET OF UISCRETE DATA POINTS. THE
	FIT IS A LEAST-SQUARES FIT, I.E., THE SUM OF THE SQUARES OF THE
	RESIDUALS IS AINIMIZED.
	THE FIT IS ACTUALLY ACCOMPLISHED BY SUBROUTINE FITT. FITTE
	ALLOCATES FIRTUAL STORAGE IN THE ARRAY HORK AND CALLS FITT
-	THIS ELIMINATES THE NEED FOR A LONG CALL LIST AND ALLOWS THE
- 6	NUMBER OF DATA POINTS AND PARAMETERS TO REMAIN ARBITRARY.
	FITTE ACCOMPLISHES THE FIT BY TRUNCATING THE TAYLOR SERIES FOR
	- EACH FITTING PARAMETER ABOUT THE INITIAL APPROXIMATION AFTER THE
	QUADRATIC TERM. AND USING THIS NEW VALUE TO REPLACE THE INITIAL
	VALUE - LIERATES THIS PROCEDURE UNTIL THE NUMBER OF SIGNIFICANT
	DIGITS DESIRED IS OBTAINED, OR UNTIL THE MAXIMUM NUMBER OF
c	TIERATIONS ALLOAD (NITMAX) IS REACHED.
- 6	TICANTIONS ACCORD THE THAT IS TO
-6 -	THE BASIC CODE IS EXPLAINED IN PRIFIT, A PROGRAM TO LEAST-SQUAR
	FIT NON-LINEAR THEORIES - SY JAMES H. HEAD, LIBRARY OF CONGRESS
	GATALOG NUMBER PAFA TR-70-5*
C	
	THE USER MUST SUPPLY THOTEL SUPPONTINES NAMED THEORY AND DERL
G	THEORY - MUST TAKE THE FOLLOHING FURN -
	THE JRY (NOATA - PAR-Y - THEOR)
G -	
G	HHERE NOATA IS THE NUMBER OF WATA PULLITS, PAR IS THE
	CURRENT VECTOR OF FITTING PARAMETERS, X IS THE ARRAY OF
G	DATA 485CISSAS, AND THEOR IS THE VECTOR OF PREDICTED
G -	THEORETICAL VALUES. THAT IS.
<u> </u>	
G -	THEOR(I) = TABUKY(X(I)+PAR)+ I=1++NDATA
2	DERIV MUST TAKE THE FOLLOWING FORM -
C -	
C	- DEFILLIT, NPAR, X, PAR, PE, PPE)
<u> </u>	The state of the s
÷	HHERE I IS THE INCEX OF THE DATA POINT - NPAR IS THE
G	NUMBER OF FITTING PARAMETERS. A AND PAR ARE AS IN
	THEURY, PE IS THE VECTOR OF FIRST PARTIAL DERIVATIVES.
	AND PPF IS THE MATRIX OF SECOND PARTIAL DERLYATIVES.
	THAT IS+
	PF(J) = O([HEORY(X(I).PAK])/U(PAR(J)). J=1NPAR
	FFIJI = ULINGUALIATED PRACTITO GRACUITA GENERAL
	2
	PPE (J.K) = 2 (THEORY (X (II , PARII/Q (PAR(J))) Q (PAR(X))
	J=1NPAR. K=1,NPAR
	THE SCRATCH ARRAY HURK ALLOCATES VIRTUAL STORAGE AND MUST BE
	OIMENSIONED

	-74/74 - OPT=1 - FTN 4.6+433	64/
G		
	- COMMON /FI/ X120001, X120001, MF 120001, MORK125061, IMEDR120001, NOA -1, HELERR, ABSERR, IFLAG, PAR 161, R, NPAR	+ 4 +
	EQUIVALENCE (KyZES)	
	EXTERNAL THEORY, DERIV	E
	SET MAXIMUMS	
6	SET TRAILERS	
-	- JATA NITHAX/503/	
	BATA NESTP/4/	
	DATA NCCSI/10/	
	DATA NSCS/50/	
	DATA NCOS/16/	
	BATA NCO2S/4/	
G	SET UP ACCOUNTING PROCEDURE	E
	DATA KKKKK/0/	
	IF (KKKKKK) CO. 1) CALL REMARK (11H* * * FITIT)	F
	- KKKKK-1	F
÷	CHECK IMPUT-PARANETERS	
	IF (NPAR-LT-1) 30 TO 11	F
	IF (NOATA-LE-NPAR) GO TO 12	. F
	30 2 I=1.NOATA	
	IF (NF(I)-LE-0-0) GO TO 13	F
	- 00 1 J=1 NDAFA	
	IF (J.EQ.T) GO TO 1	F
	IF 444 D = 60-X(T)) 30 TO 14	F
	1 CONTINUÉ	F
	2 CONTINUE	F
	IF (ABSERR.LT.J.C) GO TO 15	F
	IF (RELEGRALT	F
	IF (ABSERN-FEL-2R0.0.0) GO TO 15	F
C	SET INDICES FOR VIRTUAL STORAGE ALLOCATION	
-	- 1401050 - Av-1141040 Oroning - 104	
	NPAR2=36	
	LPF=1	
	[PF=1PF+6	
	ITHEUR=1PPF+NPAR2	
	- IC= i THEUR+NOATA	
`	10L0=IA+NPAR2	F
G		
	SET IPRN	
· · · · ·		
	IPKIN=ISIGN(1+IFLAG)	
_		
G	FIT THE DATA	F
		F
	GALL FILL (TH- DRY DERLY NITHAX NCSTP NCCSI NSCS NCUS NCCS LPRIN	
	CHECK PRINT AND ERROR FLAGS	F
		E

ROUTINE FITT	74/74	FTN 4.6+433	- 98
TE I	HELAG. EQ. 131 RETURN		
75	HFLAG.EQ.71 60 10 16		
	TROIN NE - 11 CO TO 10		
	-IFLAG+1		
	10 (3.4.5.6.7.8.9). IFL		
	U 10+4+>+3+1+3+3++ 4Fb		
	W-18, IFLAS		The state of the s
	10 10 - 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		
	VT 14- IFLAG		
	FO-10		
	FO 15 NF 21 - NIFMAX IFLAS		
	FO 16		
7 PRI	VI 20 - NCUS, IF LAG		
	FO 16 NF 22, HCO2S, IFLAG		
	VF 22, NCD2S, IFLAG		
	FO 10		
	IT 25 NCGSI , IFLAS		
			
	HT 24, NPAR		
	10 17		
12 PRI	IT 25+ NOAFA, HPAR		
	FG 17		
13 PKI	WT 26+ I+MF(I)		
14 94 [1	NT 27 - [- J - X ([])		
50 1			
15 PRI	T 28 + ABSEAN RELERR		
GO 1	10 17		
16 221	HT 29		
C			
	JRN		
	1G=10		
14 505	AT LALEAH CONGRATULATIONS.	THE SUBROUTINE CONVERGED NORMAL	LLY
	TH IFLAG=-[1-1H-]		
	MAT CALLSH THE SUBROUTING CON		AP
	ENG. THESE ARE POSSIBLE LINTT		
2-1H		HO FACULTURE LELEVISION LELEVISION	
	MAT 17/32H SUBROUTINE IS CONVE	GING VERY SLOWLY PESTONAL TO	
	C. 9 PREVIOUS RESIDUAL FOR LA		-
	AAT 177.37H SUBROUTINE WAS UNA		
	PERHAPS LESS STRINGENT EXRO		
		CITESAUCES HE REMITED IN	LHU
		ASCUST COLUTION THOSE MEN	
	HAT LILL TOSSIBLE DIVERGEN		
	HAS INCREASED BY A FACTOR OF	A PENSI TA FOR THE PUBLICATION	
	ATIONS. IFLAG: II. 14.)		
23 FOR	MAT L//. 24H POSSIBLE LOCAL MINI	HUM . 15 . 53H CUI SIEP ITERATION	
1TAKE	MANAMAN MOLTULES UN HILM NE	IFLAG = 12.1H.1	
	MAT 159HITHE NUMBER OF PARAMETE	RS MUST 35 .Gc. 1. AS INPUT.	NP
LAK .:			
			ER
	MAT (186HIT) COMPUTE A NONLING BATA POINTS MUST EXCEED THE NUM		

SUBROUTINE	FITIT-	74174	6PT=1			FTN 4.6+433	- 08/2
	2 NO	ATA = . [5-1	14 AND NPA	2 = 16-14-1			F1
	26 FORM	AT 175HITH	E HEIGHTING	FACTURE I	FOR THE UAT	A VALUES MUST	BE POSI FI
	27 FOKH	AT 151H1N0	THO ABSCI	SSA VALUES	MAY BE EQU	AL. AS INPUT	******* F1
	28 FORM	AT (106H1T	HE ERROR TO	OLERANCES !	PELERR AND	ABSERR MUST A	L HON- NE FI
	2. 49	SFR4 =-12	11-3-13+ A	NO NELERR	1 F611 . J.1	Hol	F1
	LP035	IBL: CAUSE	S ARE AN I	NCOMRECT FI	DRHULATION	IS SINGULAR.	AND/OR FI
	- 20E KI		INES - DR A	POOR INITI	AL EST IMATE	FOR THE PARK	METERS -1 FI
			•				
-							

C FITT MARREY ALLICATES VIRTUAL STORAGE FOR SUBMOUTINE FITE. FITE PRAFORMS THE ASTUME ARGUMENTS C REAFORMS THE ASTUME ARGUMENTS C NOATE		74/74 OPT=1 FIN 4.5+433 08/2
C FITT MONELY ALDCATOS VIRTUAL STORAGE FOR SUBMOUTINE FITE. FITE E REAFORMS THE ACTUAL MORK. C PERFORMS THE ACTUAL MORK. C SEXPLANATION OF SUBMOUTINE ARGUMENTS C MORTHINDUTNUMBER OF DATA POINTS IN THE X AND Y ARRAYS TO 3 F FIT. C MARKINDUTNUMBER OF DATA POINTS IN THE YAR ARRAY. C MARKINDUTNUMBER OF PARAMETERS IN THE PAR ARRAY. C THEORYXETERNALSUBMOUTINE MITTON DEFINES THE THORETICAL FIT FOR THE PARAMETERS AT I THE STREAM THE OF THE PARAMETERS THE THORETICAL FIT FOR THE PARAMETERS AT I THE STREAM THE SUBMOUTINE MITTON DEFINES THE FIRST AND SECOND FOR THE PARAMETERS AT THE OFFICE FIT FOR THE STREAM SECOND FOR THE THE RESPECT TO FOR THE PARAMETERS AND FITE FIT FOR THE STREAM SECOND FOR THE DATA AND SECOND FOR THE SEC		
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LIERALIMA TANENA	0	LITERATIONS TAKEN F.
		=7 A MATRIX IS SINGULAR. THE FORMULATION OF THE THEORY . F.
AMOVOR DERIN SUBROUTINGS MAY BE INCORRECT	***************************************	ANDVOR DERTY SUBROUTINES MAY BE INCORRECT

	74/74 - DPT=1	64/2
C		£
c		
	DINENSION PF(6), PPF(6,6), C(6), OLO(6), A(6,6)	F]
	COMMON /FIT/ X(2000) , Y(2000) , HF(2000) , HOKK(2500) , THEOR(2000) ,	
	1,RGLERR, ABSERR, TELAG, PARIS), R, NPAR	E
	EQUIVALENCE (R, RES)	E
G	04T4 UR0/7-2-15/	F;
	JATA XMAX/377677777777777778/	
- G -		F
· · · · · -	COMPUTER UNIT ROUND-OFF VALUE	E
G	LARGEST POSITIVE FLOATING POINT NUMBER	F
G		E
<u> </u>	SET INITIAL VALUES	
G -		F
	Re=AMAX1 (RELERK, URO)	
	PREV=XMAX ZNS=0 0	
	ZNS=0.0	
	10=1	
	103:0	
	N1=HCDS*NCSTP	E
£		
		5
	RN=RN+HE (I)	F
	1 CONFINUE	- F
	RN-1 /RN	
G	And the second s	
-	IF (IPRIN-EQ1) PRINT 33	
	#### BEGIN ITERATION *****	F
-6		
	00 23 M=1,NITMAX	
	KONV=1	
	NN1=N-1	
	HEGIN GUI STEP LOOP	
	JO 7 NCUT=1,NCSIP	E
	RES=+.1	F
	CALL THEORY	F.
	THEOR(I)=IHEOR(II=Y(I)	F
	RESERVED THEOR(I) THEOR(I) THEOR(I)	F
	2 CONTINUE	F
	RESERES*RN	F
	PRINT INTERMEDIATE SOLUTION VALUES. IF DESIRED	F
	PRINT INTERMEDIATE SOLUTION VALUES. IF DESIRED	
		- F
	MAI - NCUT - 4	F
	PRINT 32, AMI, NN1, RES, (PAR(I), I=1, NPAR)	F
		F

UTINE FIT	TI 74/74 OPT-1 FTN 4.6+433	64
	CH_CK RE SIDUAL AND ITERATION PARAMETERS	
- C		
	3 CONTINUE	
	IF (RES. LT. PREV) GO TO 8	_
C		
G	CHECK FOR POSSIBLE DIVERGENCE	
G		
	IF (RES.LT.13.+29EV) 50 TO 4	
	IF (103.LT.N1) 30 TO 5	-
	60 10-26	
G		
	4- CONFINUE	
		-
	NEW PARAMETER VALUES DID NOT IMPROVE FIT. TAKE AVERAGE OF OLD AT	
-	NEW PARAMETERS AND TRY AGAIN.	_
	5 CONTINUE	_
	00 6 I-1,NPAR	
	PAR(I)=(0L0(I)+PAR(I))*0.5	
	6 CONFINUE	
c		
	ENU OF CUT STEP LOOP	
		-
	7 CONTINUE	
G		-
- C	MAXIMUM NUMBER OF CONSECUTIVE CUT STEPS EXCEEDED. INCREMENT AND	
	CHECK CUT STEP ITERATION COUNTER.	_
C -		-
	IF (ID. LT. NCCSI) GO TO 12	
	GO TO 28	-
- G	TEST FOR SLOW CONVERGENCE	-
G -		
	8 CONTINUE	
	IF 125-LT-0-9*PREVI GO TO 9	
	ISC=ISC+1	
	50 10 25	
C -		-
	- WEN VALUES IMPROVED FIT. RESET ABNORMAL TERMINATION COUNTERS AND	1.
	SAVE NEW VALUES	
- G -		
	-9 CONFINUE	
	ISC=0	
		-
	10 CONTINUE	
	ID2=0	
	30 11 L=1,NPA2	
	OLOCIA REARCIA	_
	11 CONTINUE	

OUTINE FITE	74/74 32T=1 FTN 4.6+433	
	CONTINUE	
	00 14 I=1,NPAR	
	00 13 J=1,NPAR	
	A(JyI)=6.0	
	CONTINUE	
	C(I)=0.0	
	CONTINUE	
	SET UP VARIABLES TO CALCULATE TAYLOR SERIES EXPANSION	
	BO 17 K-1-NOATA	
	- 00 17 K=1+NQATA	
	CALL BERIN (KAPRAPPF)	
	-T=THEOR(K)	
	U=HF(K)	
	G= F=U	
	00 15 J=1, NFAR	
	F=PF(J)	
	C(J)=C(J)+G*F	
	00 15 I=1,NPAR	
	A(I,J)=A(I,J)+U*(I*PPF(I,J)+PF(L)+F)	
	CONTINUE	
	CONTINUE	
17	CONTINUE	
	INVERT THE A MATRIX. CHECK FOR SINGULARITY	
	CALL INVRI (A.PE)	
	IF (IFLAG. 60.7) 53 13 29	
	CALGULATE NEW PARAMETER VALUES	
G -	CALCULATE NEW PARAMETER VALUES	
- G -		
	30 19 I-1.NPAR	
	2= 3 - 0	
	ZNORM=0.0	
	DO LA J=1-NPAR	
	Z=Z+A(I+J)*C(J)	
	CONTINUE	
•	ZNOR4=AMAX1(ZNORM, A8S(Z))	
	PA+(I)=2AR(I)-Z	
	CHLCK FOR CONVERSENCE	
•	IF (ABS(Z)-GT-LRE*AdS(OLD([))+AdScRR() KUNV=1	
40	TO TAIL TO THE TAI	
	IF (KONV-64-0) 30 TO 20	
	- TL 14044+54+01 30 10 50	
-	PROCEDURE CONVERSED TO A SOCUTION	
		-
-		
	GO TO 3C	
<u> </u>	NO CONVERGENCE. TEST FOR DIVERGENCE	
Ç		
	CONTINUE	
-	IF (MM1.cQ.u) 30 TO 21	
	LE LZNORM.LE.10. "ZNS) GO TO 21	

	T
	-IF (IO2-LT-NCD2S) GO TO 22
	50 70 27
2	CONFINUE
	ID2=0
	-104=0
	SET VARIABLES TO BE SAVED AND ITERATE AGAIN
	- 25 + ANT TOPE 2 +7 AC 24AEA UNO TIESARE WATER
	CONTINUE
	2 CONTINUE
	PREVERMENT (PREVIRES)
	ZNS=ZNORM
2,	S CONTINUE
	***** CNO OF ITERATION ****
	MAXIMUM NUMBER OF ITERATIONS EXCEEDED. LIERATION MAY BE
	CONVERGING VERY SLOWLY
	IF LAG=3
	50 10 30
2	
C	-RESIDUALS ZERO- PRUBABLE CONVERGENCE WITH POSSIBLE LIMITING
	PRECISION
-	
	+ IF LAG=1
	60 TO 30
- G	SLOH CONVERGENCE. RESIDUAL IS GREATER THAN . 3 TIMES THE PREVIOUS
<u>c</u>	RESIDUAL FUR NSCS LITERATIONS
	5 IFLAG=2
	60 TO 30
C	POSSIBLE DIVERGENCE - MESIDUAL HAS REHAINED LARGER THAN LI TIMES
G	THE SHALLEST ASSIDUAL FOR NOS ITERATIONS
	6_IFLAG=4
	60 10 30
	POSSIBLE DIVERGENCE LARGEST SOLUTION INCREMENT NORM HAS
	INCREASED BY A FACTOR OF 10 FOR THE LAST NOUS ITERATIONS.
	7 LF LAG=5
	GO TO 30
	MAXIMUM NUMBER OF CONSCRUTIVE OUT STEP ITERATIONS TAKEN. POSSIBLE
	LOCAL MINIMUM ENCOUNTERED.
	& IFLAG=6
	60 10 36
C	MATRIX IS SINGULAR. THE FORMULATION OF THE THEORY AND/ON DERIV
	SUBROUTINES MAY BE INCORRECT
	9 IFLAG=7
	a Continue
	DO 31 [=1. NPAR
	PAR(I) =040(I)
	2021:1 =:::::1111
	1 CONTINUE

SUBRUUTINE FIFE 74/74 02T=1	FTN 4+6+433 95/
<u> </u>	
6	F
32 FORMAT (216,18513.5,6518.10/125x	.6518-1011 E
33 FORMAT (46HOLTERATE CUT HESI	DUAL PARAMETERSI F
END	
The second secon	

SUBROUTINE INVE	RF 74/74 OPT=1	FIN 4.6+433	0.8/2
	SUBROUTINE INVAT (A,×1)		FI
	OTHENSTON A 16-61 - X1 (6)		FI
	COMMON /FIT/ X120-01, Y120001, HF120	001 - HORKIZSUOL THEORIZODAL	MOATA EI
	1, RELERR, ABSERR, LELAG, PARISI, R. NPAR		EI
	EQUIVALENCE (R-RES)		FI
	IFLAG=1		FI
	00 4 I=1 NPAR		FI
	- 30 1 J=1 NPAR		FI
	X1(J)=A(I-J)		FI
	CONTINUE		FI
	*1(I)=1.0		£I
	IF (485(4(I,I)) LT-1		
	-00 2 J=1,NHAR		FI
	-X1(J)=X1(J)/4(I,I)		FI
	CONTINUE		FI
	00 3 J=1,NPAR		F1
	TEMP=A(J,I)		EI
	-A(J-11=4-3		F1
	-00 3 K=1 NPAR		E1
	ALJ-KI=ALJ-KI-TGHP*XL(K)		FI
	3 CONTINUE		EI
	00 4 K=1 ,NPAR		FI
	4 4(I,K)=X1(K)		FI
	RETURN		FI
	5 LF LAG=7		FI
	- RETURN		FI
	-\$NO		E1
			-
			-
		· · · · · · · · · · · · · · · · · ·	
			
			A

VARIABLES USED IN LAUNCH

ABSERR - Absolute error tolerance for parameter convergence

ALN - Number of data entries loaded in the vehicle array after processing by VEHICLE

ARAT - Percentage of failures occurring during ascent

BCONT - Name of booster vehicle contractor

BOOST - Booster designator

BV, BV1, BV2 - Booster designators for requesting output information

BVEH - Name of booster vehicle

C1, C2, C3, C4 - Designators for curve fit equations

DERIV1, DERIV2, DERIV3, DERIV4 - Subroutines defining first and second partial derivatives of the fit expression with respect to the parameters at each of the data points.

DERIV - Dummy name in FITIT and FITI to call desired partial derivative subroutine

FA - Ascent failure counter

FAIL - Total failure counter

FL - Land failure counter

FO - Orbital failure counter

FP - Pad failure counter

HEAD - Page heading array

ID1, ID2, ID3 - Launch date separated into month, day, year for printing output

IDATE - Launch date

IFLAG - Duplicate file indicator in RENMER; Error indication flag in CURVIT

IN - File designator

IO - File designator

KEY - Output request parameter indicating desired output subroutines

LATYP - Launch type nomenclature

LOC - Phase of failure

LRAT - Percentage of failures occurring over land

LTYP - Launch type designator

MULTLA - Multiple launch indicator

NDATA - Number of data points in the X and Y arrays to be fit

NEWDAT - Number of data entry cards read

NO - Percentage of launches to be considered in output subroutines

NO1 - Number of launches to be considered in output subroutines

NPAR - Number of parameters in the PAR array

ORAT - Percentage of failures occurring during orbital phase

ORGDAT - Number of data entries in updated main data file

PAR - Parameter values

PF - First partial derivative array

PPF - Second partial derivative array

PRAT - Percentage of failures occurring on the launch pad

PRODIR - Project director name

R - Residual value

RAT - Success ratio

RELERR - Relative error tolerance for parameter convergence

RES - Launch result

RESU - Launch result designator for use in output subroutines

SCR - Dummy variable used for switching data entries

SOUR - Source of information designator as indicated on data entry cards

ST - Source of information designator as stored in main data file

STG - Failed stage designator

SUCC - Success Counter

THEOR1, THEOR2, THEOR3, THEOR4 - Subroutines defining the theoretical fit values at given X values

THEORY - Dummy name in FITIT and FITI to call desired fit subroutine

UCONT - Name of upper stage contractor

UPPER - Upper stage designator

UY, UV1, UV2 - Upper stage designators for requesting output information

UVEH - Name of upper stage

WF - Weighting factors for curve fit data

WORK - Dummy work array

X - Abscissa data variables (launch number)

Y - Ordinate data variables (historical reliability)

All other variables are dummy variables.

ABBREVIATIONS

AFETR - Air Force Eastern Test Range

AFWL - Air Force Weapons Laboratory

ANSI - American National Standards Institute, Inc.

ARPA - Advanced Research Projects Agency

DOD - Department of Defense

EOF - End-of-File

ERDA - Energy Research and Development Administration

INSRP - Interagency Nuclear Safety Review Panel

LES 8/9 - Lincoln Experimental Satellites 8 and 9

MJS - Mariner Jupiter/Saturn

NASA - National Aeronautics and Space Administration

SER - Safety Evaluation Report

VAFB - Vandenberg Air Force Base

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